THE ENGINEER.

British Agricultural Machinery for the Colonies.

AGRICULTURAL ENGINEERING.

IT is, we think, desirable to explain in as few words as may be why we have selected agricultural implements as a subject for a Supplement to THE ENGINEER. This is the more necessary that we have been told that it would be useless, because farmers do not read THE ENGINEER, and no one else is interested. We happen to know that the first statement is not true; and as regards the second, it would appear that the agent or middleman has been forgotten. Our main object is not to address the British farmer, but to supply men in our various colonies and dependencies with instruction, and to show them that in this country the agricultural implement maker has not fallen asleep. It will be easily within the memory of many of our readers that statements have been widely circulated to the effect that the United States is the country in which all that is latest and best in the world the reaping machines of the Grantham firm carried off the prizes. The world has been supplied continuously with thrashing machines turned out in thousands by English firms. The late Richard Garrett the elder, of Leiston, in Suffolk, the founder of the present firm some 130 years ago, was the first man to make a seed drill and a horse hoe on scientific principles. It would take too long to recount what such men as Howard, of Bedford, and Ransomes, of Ipswich, have done in the development of ploughs.

It is indisputable that at the present time a great deal of good agricultural machinery and implements is made on the Continent. The better types are modifications—not always judicious—of English ideas. In the United States a great deal of attention has been devoted to the production of machinery which is competent to do special work. Protection effectually prevents the American and Canadian farmer from freely using the machinery or implements made in this country, and it is not at all unusual to hear it said that American machinery is very much better for Colonial use than that made in England. Such statements originated with those who have no practical knowledge of what we can and cannot do. There the American reaping machine has to deal with crops of about one-half the weight usual in England. Wheat 6ft. high is not uncommon in this country; it is seldom more than 3ft. high in the United States. There is, no doubt, one objection to English implements which is, in its way, well founded. They are too heavy and too good. In Canada, for example, it is far more important that a portable engine should be light than that it should be economical in fuel or long lived. As the English builder has small chance of selling his machinery in America, the matter is, after all, of little importance to him.

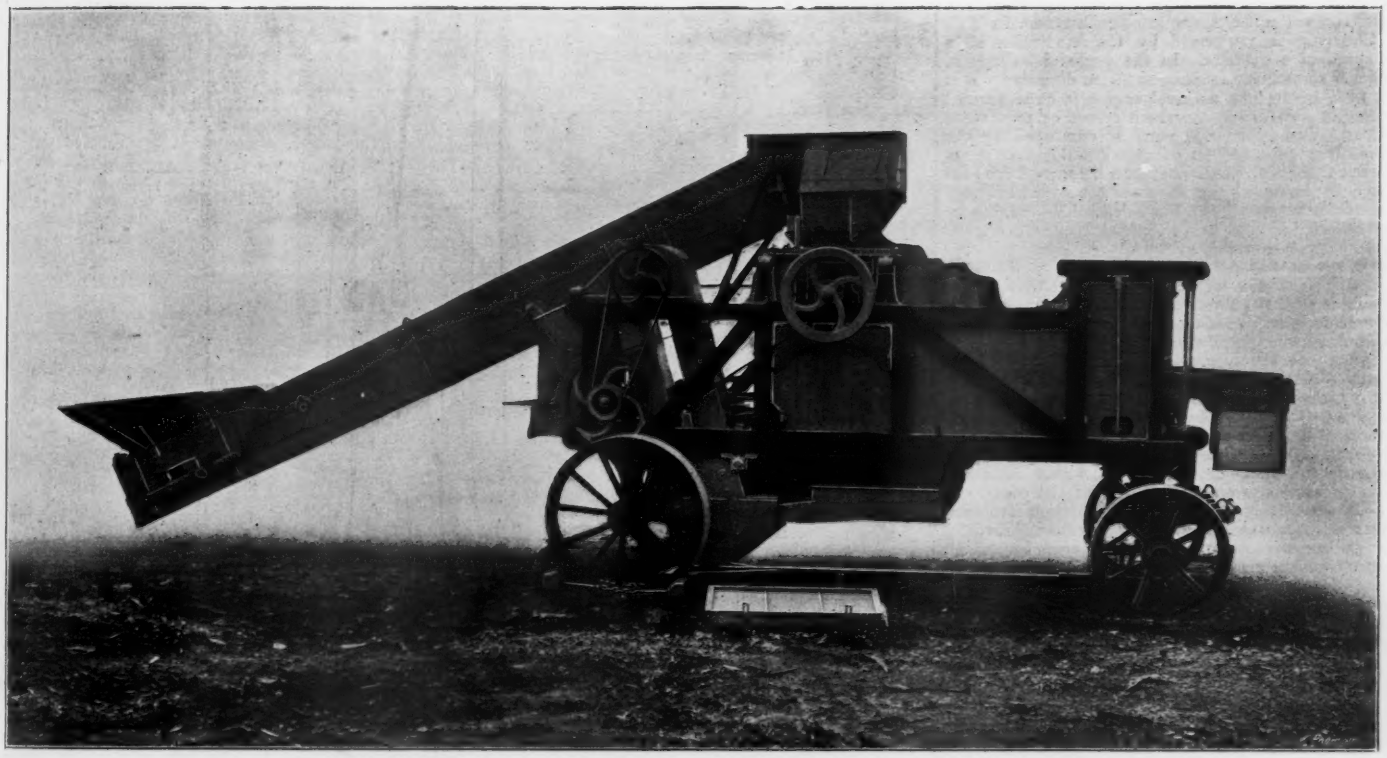
Finally, we may say that it is often stated that the American knows better what is wanted abroad, and is more willing to supply it than the Englishman. That is not true, at all events as baldly stated. The English agricultural engineer and implement maker has spared no pains and no expense to supply himself with information as to what is wanted by possible customers all over the world. There are some implements, however, which it would not be worth his while to attempt to produce. The Indian ryot uses a plough which costs about one rupee. No English plough maker could compete for such a market. British manufacturers of all kinds have been curiously misrepresented. We venture to say that none have suffered more in this way than the agricultural engineer and implement maker.

THE THRASHING MACHINE.

THE modern finishing thrashing machine is full of secrets revealed only to the initiated. Apparently simple, it is essentially scientific. It is beneath the dignity of the professor and the mathematician to study it; yet its dynamics abound in interesting surprises. It is not quite within the province of the mechanical engineer; yet its success depends on the satisfactory solution of numerous problems in mechanics. We venture to think that even those of our readers who are not practically concerned with agricultural machinery may find something to interest them in what follows.

To give some idea of the importance of the trade in this class of machinery, it may be enough to say that in Lincoln alone the output is 1700 to 2000, and in England from 4000 to 4500 per year. The selling price of a machine being about £140, it will be seen that the gross value amounts to the not inconsiderable sum of £600,000 a year.

The finishing thrashing machine removes the corn from the straw. It shakes the straw lest grain should be carried away. It delivers the straw in one place. In the process of thrashing some of the straw is broken into small pieces. These, with the leaves of the stalks, blind heads, and light rubbish constitute together what are known as "cavings." These cavings have to be singled out and delivered in another place. The chaff has to be got rid of, and that also is singled out. Lastly, the grain has to be cleaned and winnowed and delivered free from the seeds of weeds into sacks. Small, light, imperfect grain must also be sacked. It will be seen that the number of operations carried out by one machine is very considerable. Each of these functions is a delicate operation, and it must be performed equally well whether the corn is good or bad. Again, the machine must be competent to deal with materials as diverse from each other as wheat and peas, rye, oats, and barley. No amount of technical education would enable a man to design and construct a thrashing machine which could satisfy the ruling conditions of trade; nothing but long practical experience can supply the requisite knowledge. Much excellent work is done for which none but a rule-

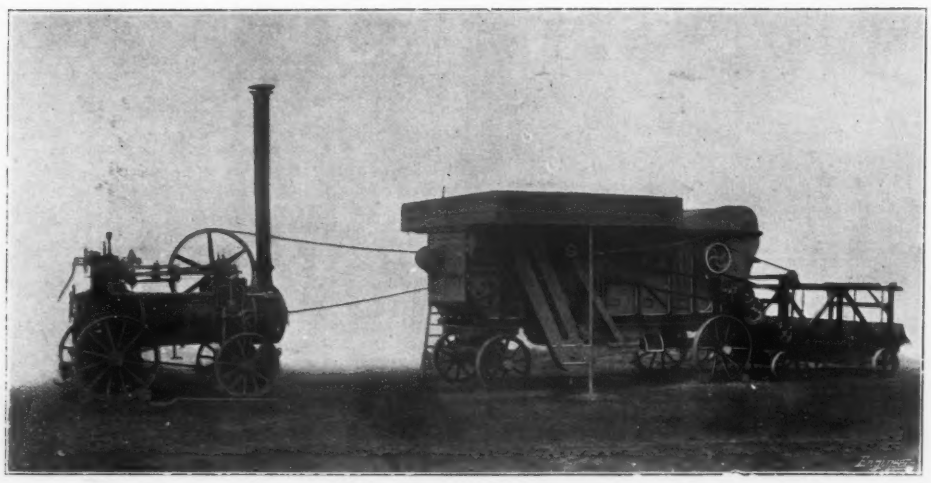


RUSTON AND PROCTOR'S MAIZE HUSKING AND DRESSING MACHINE

machinery used by the agriculturist is to be found. It is worth while to refute this calumny, and to bring before the world the truth that all that is best in the mechanism used in tilling the ground, in sowing and reaping, in thrashing and grinding, can be had in Great Britain.

The invention and construction of agricultural machinery began in this country, and there is probably not one important invention which has not originated or been developed here. The portable engine and steam thrashing machine originated with Clayton and Shuttleworth. Under the stimulus of the rewards offered by the Royal Agricultural Society the portable engine was so much improved that at this moment the "racing portable" remains the most economical non-condensing small power engine ever made. Steam-ploughing was invented, if we may use the words, by John Fowler. It was developed by him in conjunction with John Smith, of Coven, in Staffordshire. Multitudinous improvements were subsequently effected by David Greig, Max Eyth—members of the Leeds firm—Thomas Aveling, Fisken, and many other engineers. The steam plough is of purely British origin. A reaping machine was invented in the United States, but it had been preceded by one invented in Scotland. The first commercial reaping machine seen in this country was made by Messrs. Burgess and Key as far back as 1858. It was a large and heavy machine, and was supplanted by a small one invented by Wood, an American. But Hornsby came on the scene, and at all competitions everywhere in the

of-thumb reason can be given, and we are by no means certain that any amount of scientific investigation would help in the least.

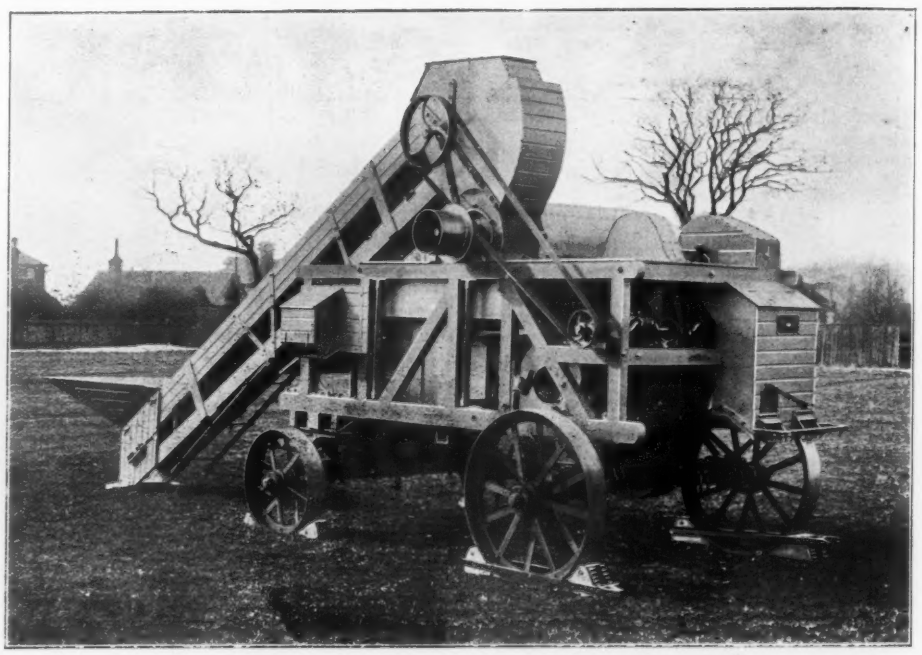


RUSTON AND PROCTOR'S THRASHING PLANT

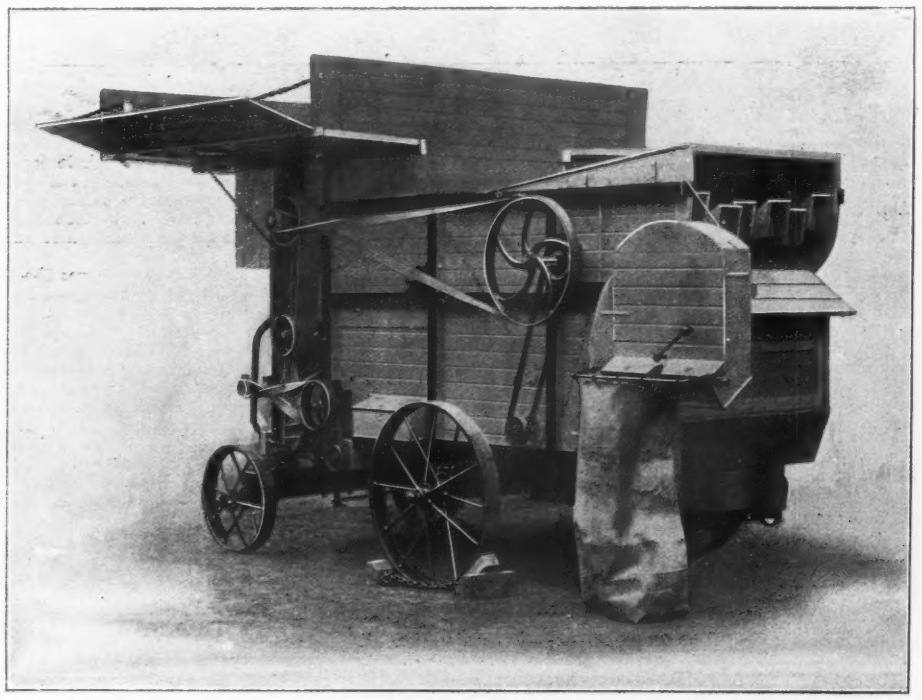
The thrashing machine consists of a box, with a strong built-up frame. Inside this box are the drum, the breast, or concave, the straw shakers, the shoes, the fans, the riddles, and the screens. Outside is the elevator and the belts by which motion is imparted to the various members of the whole machine. There are two types of thrashing machines—those with "peg and beater" and those with drums. The first is still in favour to some extent in Canada, the United States, and Scotland. The second is by far the more important type. In both the thrashing is performed by the revolution at a high speed of a cylinder. In the peg and beater the cylinder is sometimes as much as 3ft. in diameter. It is made with staves like a barrel, only it is quite parallel from end to end. In it are stuck spikes or pegs some 6in. long. The cylinder is partially enveloped by the "breast" or "concave," an openwork lantern-like structure, also fitted with pegs. Between these pass the pegs in the cylinder, just as the fingers of the right hand may be passed between those of the left. The corn to be thrashed is fed in head first lengthways, and the grain is combed out, so to speak, by the revolving spikes. The speed of revolution varies between about 300 and 500 per minute. The special advantage possessed by this type of machine is that the straw is not broken up, and can be used for thatching ricks and houses. In the old-fashioned peg and beater machines, barn fixtures driven by horses, the straw was carried away by two large four-armed reels, one behind the other and fitted with forks which shook up the straw, the grain falling through a grating under the reels. It is not necessary to say more of this class of thrashing machine.

In the modern steam thrasher the grain is rubbed out of the ears by "beaters," six or eight in number, extending from a spider at one end to a spider at the other, one or two intermediate spiders stiffening the whole structure, which resembles a squirrel cage. This "drum" revolves inside a concave, built up of transverse bars. Its distance from the drum can be adjusted. The diameters of the drums vary, some makers using one size, some another. Twenty-two inches is a common diameter. The drum is caused to rotate by a belt, usually about 8in. broad, from the fly-wheel of the portable engine. The speeds vary with different machines between 900 and 1300 revolutions per minute. The latter is quite exceptional. It will be seen that the construction of the drum involves some very nice problems. The centrifugal force is very great, and the least want of balance would mean destruction. After the drums have been made they are hung on knife edges under the journals, and most carefully balanced by nailing small bits of lead to the wooden beaters. These beaters are by some makers faced with angle steels only, others use the diagonally-ribbed beaters first introduced by Garrett, of Leiston. Very accurate and substantial workmanship is essential. The drum spindle is usually fitted with several pulleys at both ends to take belts which drive the various parts of the machine. The corn is fed in between the drum and the concave crosswise. The bands of the sheaves are cut by men on top of the machine, and the loosened sheaves are then thrown into the "mouth" and dealt with by the drum. The straw is flung out on the shakers, which consist of six long narrow "boxes," with cross ribs of wood. These are mounted on two cranks, and have a motion precisely like that of the side rods of a locomotive. They are so arranged that three alternate boxes are up and three down. The shaker cranks revolve rapidly, and the straw is tossed up and down and carried forward up a slight angle to the end, where it is delivered—very often, in the present day, to an automatic stacker—otherwise on the ground, whence it is removed by men with pitchforks. The cavings, chaff, and corn fall all together on a riddle, which oscillates backwards and forwards. The cavings pass on to a side spout. The chaff and grain fall in front of a blast from a fan. The grain is then delivered to an elevator, which takes it up and passes it through a series of screens and past various fan blasts. Sorting takes place, and, finally, the good grain is delivered into one sack and the inferior grain into another.

All this seems very simple and straightforward. The reality is very complex. To begin with, the precise relations of the drum and concave are not fully understood. It is assumed that the grain is rubbed out by the rapidly flying "beaters." Other authorities say that it is beaten or shaken out. All that is definitely known is that unless the beaters are of the proper dimensions and proper shape corn will escape unthrashed. Many attempts have been made to invent improved beaters and drums. None of these have come to much. All the principal makers, however, have hit upon a system of drum construction that leaves little hope of any improvement. Each has his own proportions, and each naturally thinks that his own is the best. The result has in all cases been got by trial and error. Very large sums indeed have been expended in experimenting with thrashing machines, and it may, we think, be taken as certain that finality, or something very like it, was reached several years ago in their design.



GARRETT'S MAIZE SHELLER



GARRETT'S CLOVER HULLER

We may turn now to the peculiarities of the machine. In the first place, we have, as stated, a heavy revolving drum to be balanced with minute accuracy. Next come the shakers, which compensate each other. Lastly, we have the shoes, which weigh several hundred pounds, and oscillate with a stroke of 6in. to 10in. at various but always comparatively high speeds. Everything possible is done to make these also self-compensating, but it is not always easy to make one riddle move in one direction while another moves in the opposite sense. Thus, the balancing of reciprocating masses becomes as important in the thrashing machine as it is in the locomotive engine. The connecting-rods from the cranks are always now made of ash and flattened, so that they act as springs, and there is no joint at the small end. The shoes are hung, not in links, but on flat wooden springs, sometimes jointed at the lower end, in others bolted both to the shoe and the frame, so that the spring has to submit to a double flexure.

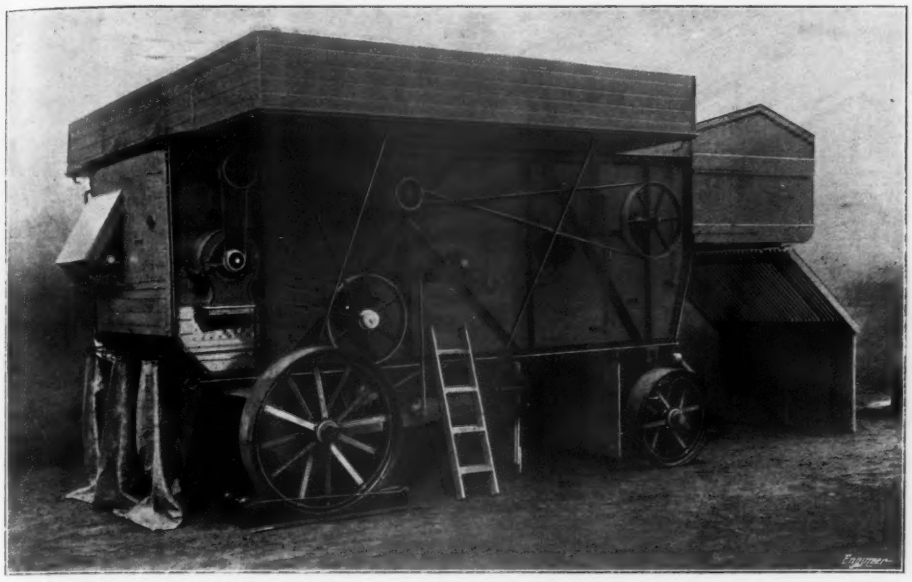
The cavings and chaff are very difficult to manage. Whether they will descend an oscillating shoot at the proper speed or not depends on the angle of inclination and the condition of the stuff, as to whether it is dry or wet. The construction of shoots and riddles, their proportions and angles, the size and arrangement of the holes in them, constitute an art, and the difference between a riddle that will continuously clog and one that will always keep clear is very frequently one that may be felt by the expert, but cannot be seen by the outsider.

The construction and proportions and speeds of the fans are matters of the last importance. A mistake here will lead either to the corn being very badly cleaned, or to some of it being blown away in the chaff. Probably in no department, if we except screens, has there been more experimenting than with fans. Some makers use several fans, each doing its own work. Others use one master fan which delivers wind into different trunks, from which it is led to the departments where it is needed. Garrett and Sons, of Leiston, at one time mounted a single fan on the drum shaft, and so saved a belt. Smith, of Coven, in Staffordshire, built in 1862 a 54in. thrashing machine, in which a single fan was used; this not only supplied wind, but it sucked up the grain from a saucer-shaped box into which it was delivered as thrashed and first winnowed, so that no elevator was needed. The corn passed through the fan, which knocked off the beard from barley and rye, thus taking the place of the "chobber" fitted to nearly all machines. The invention was not a success, as too much was attempted, and the finished sample was not properly cleaned. The number of inventions in the way of screens that have been tried is legion. Perhaps the most ingenious ever adopted was that invented by Mr. Brinsmead, who was in charge of the thrashing machine department of Ransomes and Sims, of Ipswich, in 1863. This was a horizontal revolving screen, the wire being wound spirally. In all such screens the corn tends to clog between the bars, and a revolving brush is kept in contact with the surface of the screen to sweep out the grain. Mr. Brinsmead, by a beautifully simple device, made the wires separate a little at the top as the screen turned on its axis, and the stuck grain fell out.

It will readily be understood that a good deal of power is required to drive a large thrashing machine. The corn to be thrashed acts as a brake applied to the surface of the drum with an angular velocity of about 50 miles an hour. At this speed a very moderate resistance requires a large power to overcome it. Very little definite information, however, exists on the subject. As a rule an eight horse-power portable engine is sold with the 54in. drum machine, and with a pressure of 60 lb. it will drive the thrasher.

In 1872, at the Cardiff Show, a series of trials were carried out by the Royal Agricultural Society. Full particulars were given in our July issues for that year. good corn delivered was about 6 cwt., and the horse-power delivered to the machine varied between 7·66 and 10·83 horse-power. There was very little connection between the time and the power. Curiously enough, the non-finishing machines, which had fewer parts, required more power. The time occupied was about the same, the quantity of grain about 6 cwt, and the power from 12·21 to 13·66 horse-power. We cannot attempt to offer an explanation of this anomaly.

In 1891 a trial took place at the Doncaster R.A.S.E. Show. The complete table of results will be fouud in our impression or July 3rd, 1901. In the table on age iv. we



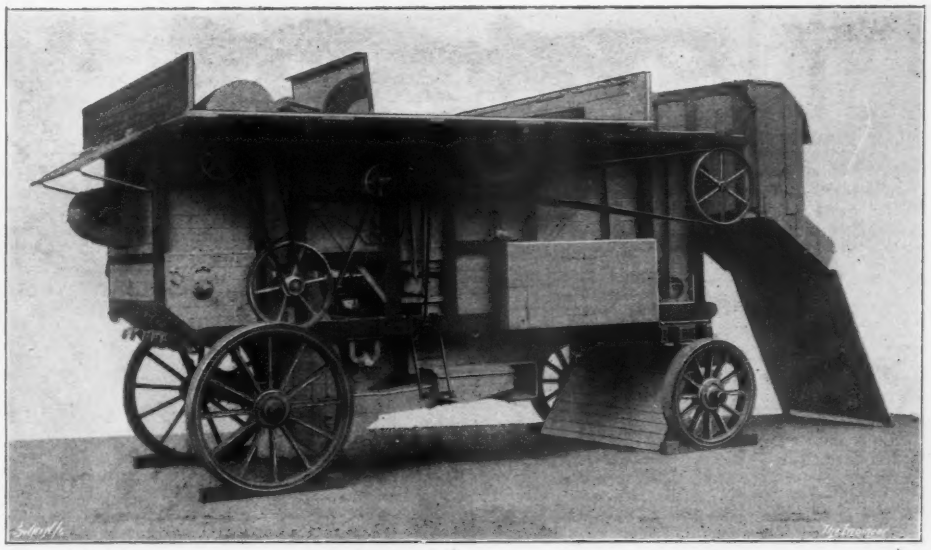
ROBEY'S THRASHING MACHINE

We must content ourselves here by saying that the time required by the competing finishing machines, which were all 54in. wide, to thrash one ton of wheat varied between 15 minutes and 20·5 minutes. The weight of give particulars concerning three of the competing machines, which will be found to supply a good deal of detailed information.

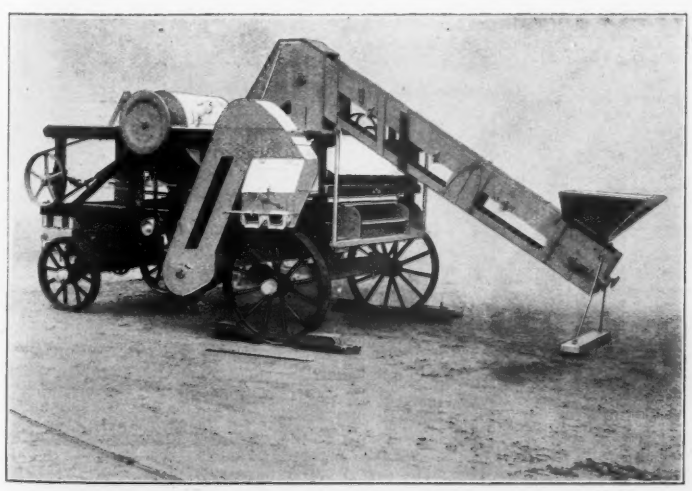
There are well over a dozen different British firms who exhibit thrashing machines annually at the Royal Agricultural Society's Show. There are possibly as many more makers who do not exhibit, so that all we can hope to do in the space at our disposal is to mention a few machines by well-known makers. It is to a certain extent remarkable that firms which have long ago given up the manufacture of agricultural implements properly so called, but have turned their attention mainly to the construction of steam engines and boilers, and more lately to oil engines, still continue to make thrashing machines. The reason is possibly to be found in the fact that such machines are not infrequently ordered in connection with portable or stationary engines to drive them, and the companies who make one find it convenient also to make the other.

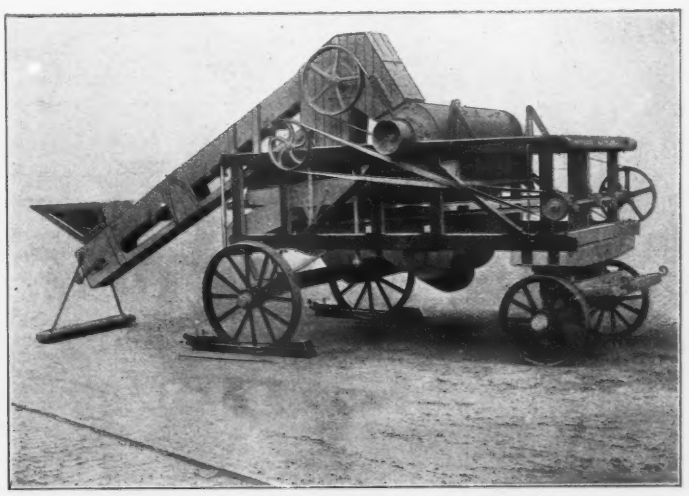
The tendency in the Colonies with regard to thrashing appears to be: (1) The adoption of self-moving engines frequently fitted to burn straw when thrashing and wood or coal on the road; and (2) to continually increase the rapidity of output. Mr. Garrett informs us that he has but recently heard of such an enormous output as 40 tons of wheat—about 1500 bushels—thrashed and dressed per day by each machine, and as much as two sacks of 280 lb.—560 lb. in all—of clover seed per hour.

One of the best machines of this kind is made by Marshall, Sons and Co., Limited, of Gainsborough, and the most recent design, embodying several modifications in details, is illustrated below. The machine shown is of a large, but not the largest, size, being 4ft. 6in. wide, and it thrashes, dresses, and finishes the grain, thus preparing it for the market at one operation. It has a 22in. drum, and a 14 to 15 brake horse-power engine is required to drive it. In ten hours it will deal with 700 to 750 bushels of grain. A bigger machine than this is is made, and will treat about 100 bushels per hour, or about 26 tons per day. It is 5ft. 6in. wide, and has a drum 24in. diameter. The smallest thrasher and finisher built by this firm is only 2ft. 6in. wide, with a 20in. drum; requires 8 horse-power to drive it, and delivers a maximum of 360 bushels per day of ten hours. The machine, as illustrated, is made for travelling, and its compactness makes it particularly well fitted for such work, but instead of being mounted on wheels it is not infrequently on big farms put down on fixed foundations. The straw, cavings, and chaff are delivered from the machine at the end furthest from the engine, whilst the finished grain issues from the other end, as far away as possible from the dust and dirt incident to the first operation. The corn is separated into three qualities, and these are readily varied by contracting or expanding the screen. The vibrating shoes are suspended on spring hangers and driven by spring rods, thus reducing the number of pins needed, and the



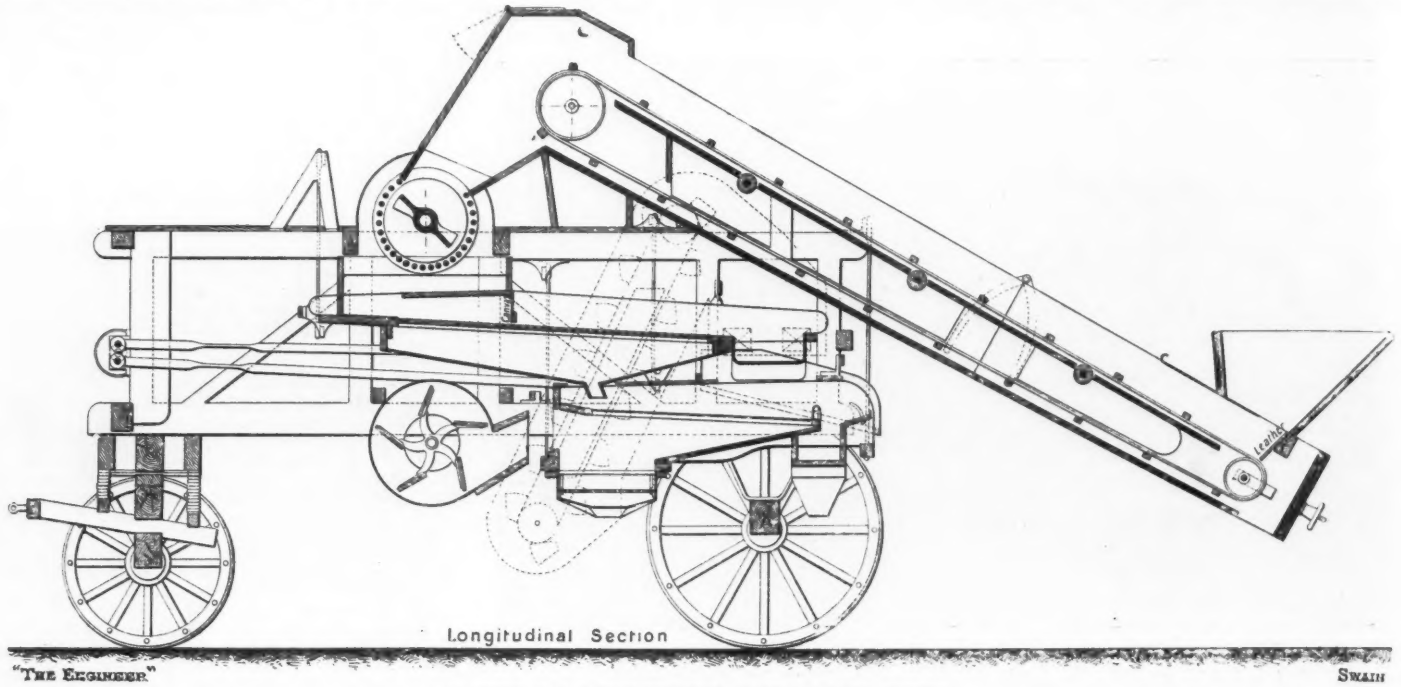
MARSHALL'S THRASHING MACHINE





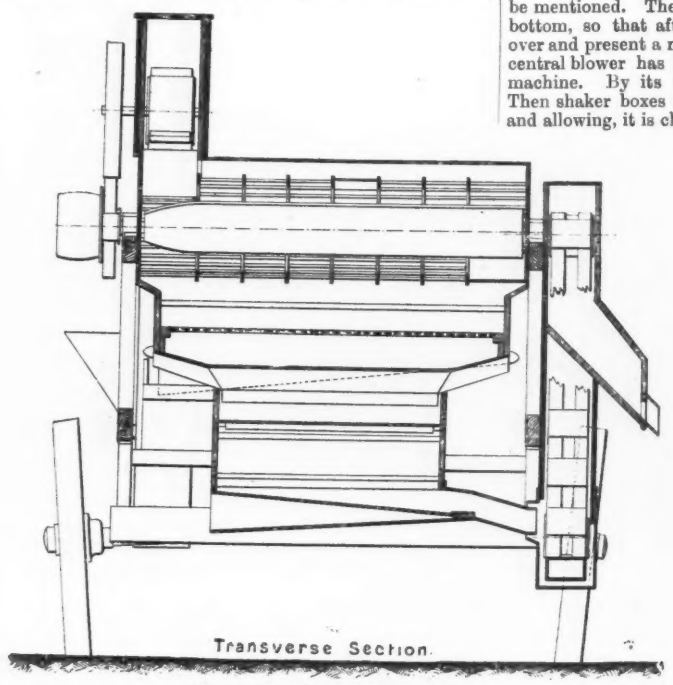
CLAYTON AND SHUTTLEWORTH'S MAIZE SHELLER

consequent attention and lubrication. By an Act of Parliament of 1879 anyone using a thrashing machine in England without guards for the drum and feeding mouth the entrance. There is also protection from the back, a hood being provided, which drops over the drum if any weight falls upon it.



CLAYTON AND SHUTTLEWORTH'S MAIZE SHELLER SECTION

is liable to a pretty stiff penalty. We do not know that the Colonies have yet adopted regulations of that kind,



MAIZE SHELLER—CROSS SECTION

but it may interest colonists to know that this machine is fitted with a cover over the drum, which is released if any undue pressure comes on the feed board and closes

Of the improvements which have been added to this machine the introduction of reversible concaves may first be mentioned. The latter are reversible both at top and bottom, so that after some years they can be turned over and present a new edge to the drum. Secondly, a central blower has been fitted at the back end of the machine. By its use the creeper is dispensed with. Then shaker boxes of a new pattern, fitted with steps, and allowing, it is claimed, the straw to lie more lightly, and giving it a better shake and straighter delivery, are used. Another item of some importance is the employment of friction-holders for the sack in place of the usual hooks. Finally, attention may be directed to the swivelling ring oiler bearings which the makers apply to the drum shafts of all their thrashing machines. The bearings consist of an outer case or pedestal of cast iron, the lower part of which forms a receptacle for oil, containing two brasses which swivel on top and bottom centres within the pedestal, and thus allow the shaft to take its own alignment. Two rings which, fitting very loosely on the shaft, lie on top of the journal and dip in the oil bath, by their revolution, caused by their friction with the journal, keep the bearing well supplied with oil. Deep grooves are cut in the upper brass to admit these rings. A slot in the side of the pedestal covered by a glass plate allows the amount of oil to be seen.

CLAYTON AND SHUTTLEWORTH'S COLONIAL THRASHING MACHINE

Another example of a machine for treating maize is

The Royal Agricultural Society's Thrashing Machine Trials.—Construction, Speeds, Surfaces, Speed and Surface and Drum Relations.

Name of Maker.	Nominal power.	Catalogue price.	Weight.	Drum. Diam'r.	Drum. Length.	Drum. Revs per min.	Drum. Circum. velocity.	Drum. Col. Col 8 × 6 = surf'e per min	Drum. Beaters.	Drum. Weight*	Shakers. How worked	Shakers. Strokes per min.	Shakers. Stroke.	Shakers. Ft. per min. Col Col 13×14	Shakers. Coeffic't Col. Col. 15 ÷ 8	Shakers. No. box's & length.
				in.	ft. in.		ft per min	sq ft		lb			in. ft.			
Foster, W., and Co. ...	8	£155	Cwt 75	22·0	4 5	1000	5750	25,375	8 Goucher	280	2 cranks	300	4·5=·375	112·5	·0196	4 11′4
Tasker, W., and Sons...	8	£140	86	21·5	4 5·75	1065	6000	26,875	8 Grays	389	2 cranks	332	5 =·416	138·0	·0222	4
Foden, E., Sons and Co.	8	£145	76	22·0	5 5·5	1032	5944	26,498	8 Goucher	442	2 cranks	358	5 =·416	148·9	·0250	4 11′0
Mean	—	—	—	—	—	103.	5894	26,249	—	—	—	330	—	133·1	·0223	—

Name of Maker.	Caving Riddles. Length.	Width.	Strok s per min.	Stroke.	Ft. per min. Col Col 20 × 21	Coeffic't Col. Col. 22 ÷ 8	Area.	Col. Col 22 × 24 = surface per min.	Coeffic't Col. Col. 25 × 9
	ft. in.	ft. in.		in. ft.			ft.	sq. ft	sq. ft.
Foster, W., and Co. ...	5 6	3 10·5	344	3·0=·25	86	·0149	21·2	1823	0·0718
Tasker, W., and Sons...	4 9	4 2	434	4·5=·375	162	·0271	19·75	3210	0·1190
Foden, E., Sons and Co.	5 1	4 0	382	3·0=·25	95·5	·0160	20·3	1940	0·0732
Mean	—	—	387	—	114·5	·0193	20·42	2324	0·880

Name of Maker.	Dressing Riddles.† Length.	Width.	Area.	Stroke.	Stroke per min	Feet per min.	Col. Col. 29 × 32 = sq. ft. per min.	Coeffic'nt Col. Col. 33 ÷ 9	How worked.	Fan (1st blast.) Diam'r.	Length.	Revs.	Fan (2nd blast) Diam'r.	Length.	Revs.
	ft. in.	ft. in.	sq. ft.	in. ft.						ft. in.	ft. in.		ft. in	ft. in	
Foster, W., and Co. ...	2 10·5	1 6·5	4·42	3·0=·25	344	86	380	·0149	Riddle crank	1 10	2 10	—	1 8	0 4½	—
Tasker, W., and Sons...	2 9	1 8	4·57	4·5=·375	434	162	758	·0283	Riddle crank	2 2	2 9	493	No	2nd	fan
Foden, E., Sons and Co.	4 25	1 10	7·72	3·0=·333	382	95·5	735	·0277	Riddle crank	2 6	0 8	1025	1 8	0·45	1025
Mean	—	—	5·57	—	387	114·5	624	·0236	Riddle crank	—	—	—	—	—	—

Name of Maker.	Finishing Riddles. Length.	Width.	Area.	How worked.	Screen. Name.	Diam'r.	Revs.
	ft. in.	ft. in.	sq. ft			in.	
Foster, W., and Co. ...	1 4	2 4·25	3·13	Riddle crank	Rainforth's	18	35
Tasker, W., and Sons...	1 10	2 6	4·58	Riddle crank	Rainforth's	18	—
Foden, E., Sons and Co.	No	finishing	g sieves	used	Penny	20	—
Mean	—	—	—	—	—	—	—

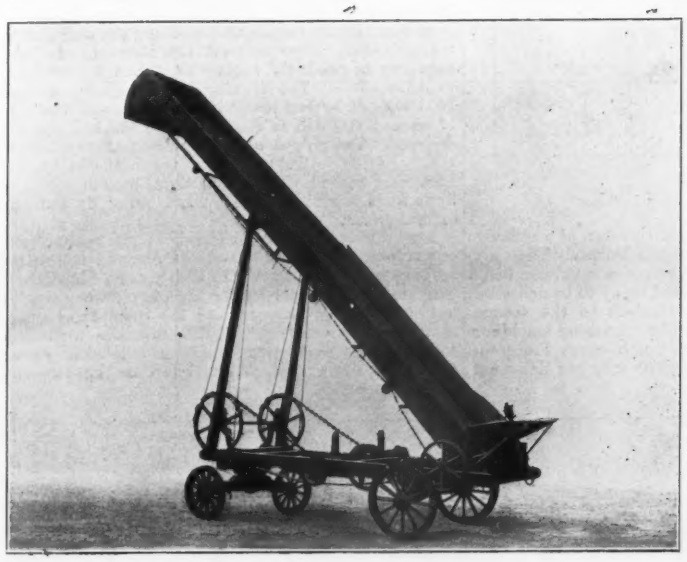
* With spindle and pulley. † The dimensions here given are those of the grain sieve.

STRAW ELEVATORS

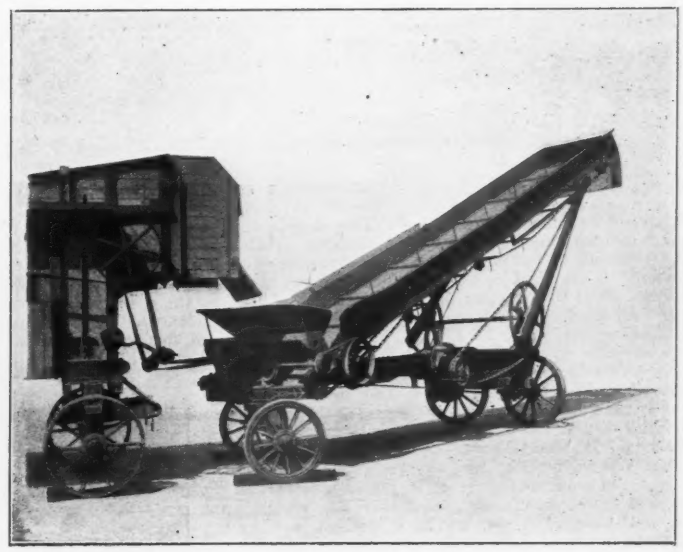
(*For description see page* vii.)

MARSHALL'S FOLDING ELEVATOR—CLOSED

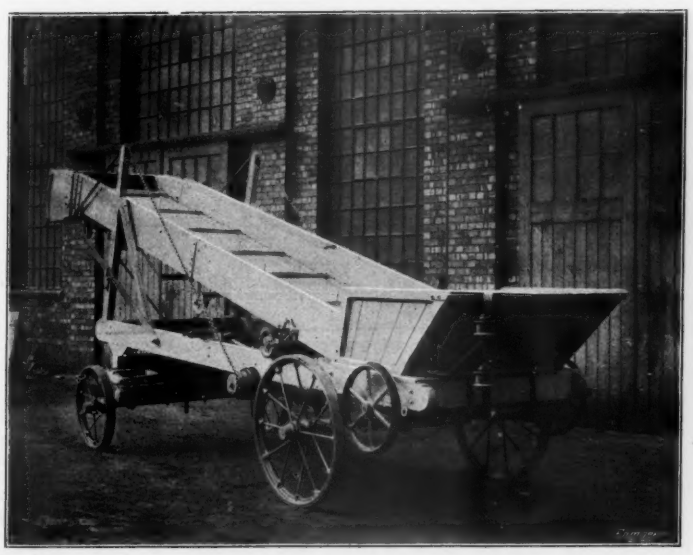
MARSHALL'S STRAW ELEVATOR



MARSHALL'S FOLDING ELEVATOR—OPEN



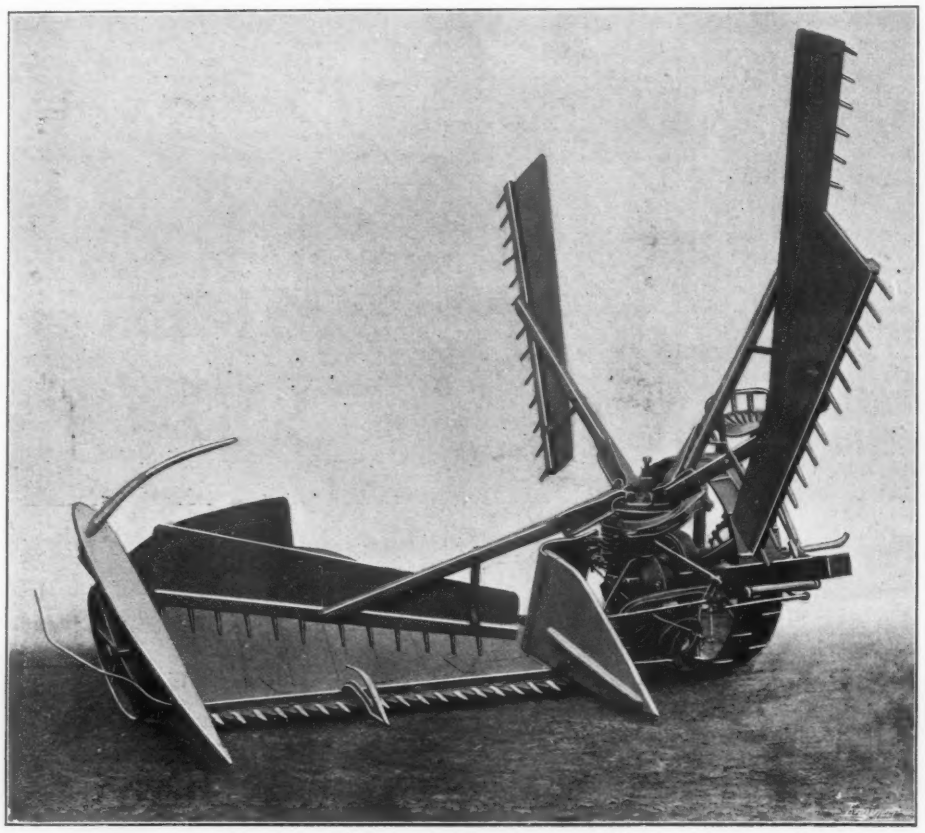
MARSHALL'S SWIVELLING ELEVATOR



ROBEY'S TELESCOPIC ELEVATOR—CLOSED

ROBEY'S TELESCOPIC ELEVATOR—OPEN

afforded by the illustration on page i. This machine is made by Ruston, Proctor and Co., Limited, of Lincoln. The cobs are fed into the hopper at the end of the long arm, and carried to the top of the machine, whence they fall into an iron cylinder, where a rapidly revolving drum of special construction strips off the grain, leaving the cobs whole and suitable for fuel. Riddles are provided for separating the empty cobs, and a strong blast of air blows out the dust and loose husks; stones and other refuse are sifted out by fine riddles; the grain after complete treatment is finally elevated to the



SAMUELSON'S SELF-RAKING REAPER

sack spouts in a finished condition. Iron wheels are fitted to this machine to suit it for hot climates, and the elevator is made to fold up into halves for convenience of travelling. A 5ft. machine like that illustrated will shell and dress about 900 quarters of maize in a day of ten hours. An illustration of a complete plant for thrashing and finishing, made also by Ruston, Proctor and Co., is given on page ii. It consists of a portable engine driving a thrasher, the end of which is provided with a bruising barrel for chopping and breaking up the straw, which is then delivered on to the sifters at the end, by which the chaff and dirt are separated out.

Although Richard Garrett and Sons, Limited, of Leiston Works, Suffolk, have probably as great an experience in the manufacture of thrashing machines as anyone in the country, their record extending certainly over one hundred years, we have decided to give preference to two of their machines which are, perhaps, less widely known, and we illustrate, therefore, on page ii. a clover huller, which they have spent no little time in developing, and a maize shelling machine. The first of these is designed to compete with American machines of the same class, and, it is needless to say, is of more substantial build. Cast iron has been dispensed with as far as possible, wrought iron and steel being used to replace it. A brief description of the machine may not be out of place. Two drums are employed; the first does the thrashing of the seed, and is made like the drums in Garrett's thrashing machines; the second is a peg drum for rubbing out the seeds. The first strips off all the heads or cobs of clover, passing them on to the second drum, whilst the stalks or straw are delivered to the shakers, which separate from it any cobs or seeds which may have been carried through. Everything that passes through the grating of the top drum and the shakers passes over a special sieve, which separates out plantain seed, dust, dirt, &c.; thence the product enters the wooden caving sieve, where the larger pieces of straw or cavings are separated from the seed cobs and chaff and finally delivered out of the machine. The seed cobs and chaff that pass through the caving sieve enter the bottom drum. This drum runs at 1500 revolutions per minute. Seed, chaff, dirt, &c., fall on to the blowing riddles, where the blast carries away everything but the seed, which is then conveyed to the second dressing apparatus. Here it again falls on to sieves and once more is subjected to the blast, and finally passing over a dust sieve, it is delivered into sacks. The tailings, both from the second blast and from the blowing sieves, are elevated back to the shakers.

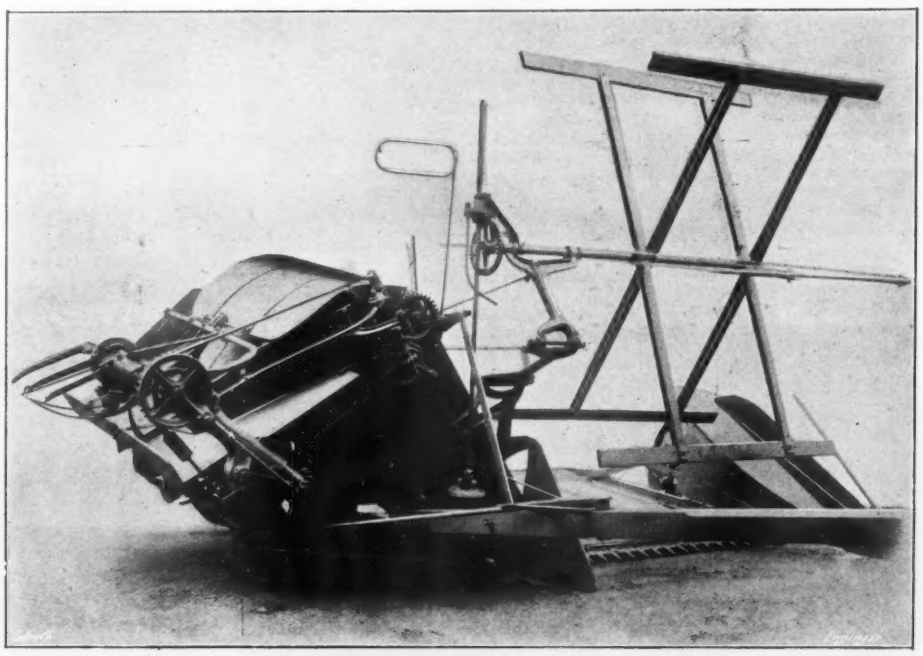
Both the drums are carried in strong cast iron panels, and their concaves are readily adjustable to suit the crops whilst the machine is at work. To allow of the lower drum being removed for cleaning, the top of the second concave can be swung to one side. The pegs of the milling drum are made of hard and tough steel. All the bearings are of Babbitt's metal and are interchangeable. The quantity of seed thrashed per hour from a good average crop is about 420 lb.; with a light crop the delivery is about 280 lb. per hour. The main body of the machine is made of well-seasoned oak. Belts are used for driving throughout, being considered preferable to chains.

The maize shelling machine made by this firm is illustrated on page ii. It is a very substantial machine, made to stand rough usage. It works as follows:—The maize cobs are fed direct from the wagon or from the ground into the hopper of the cob elevator, of which the height is adjustable to suit the conditions. They are thence conveyed to a cylinder where a revolving helix rubs the shells off, leaving the seed ready to be delivered to the main riddle. Thence it passes to the second riddle, which is much like that of a thrashing machine; and, finally, on to a third riddle, which leaves the grain clear and bright. The larger shelled cobs are delivered from one side of the machine, and can be preserved for fuel, whilst the broken cobs come out of a spout on the opposite side, and are used at once in the engine working the machine. When very tough or damp maize has to be dealt with, or when the wings of the helix have become worn from use, the size of the delivery opening of the cylinder can be easily reduced so that each charge is longer under treatment. The helix should be run at between 790 to 800 revolutions per minute, not more nor less, and the cobs require to be fed pretty uniformly. A 60in. machine, working under good conditions, will shell and clean from 100,000 to 150,000 kilos. of maize in ten hours.

On page iii. we show a thrashing machine made with an angle iron frame—a standard type manufactured by Robey and Co., Limited, Lincoln. This machine has been specially designed for use in countries where a large duty is expected from it. In place of the usual sorting screen a third blower has been fixed, which has the same effect as the screen, dividing the grain into three grades, but it is of greater capacity, and serves also as an additional dresser. In countries, however, where it is desired to screen the grain the usual wire sorting sieve, which is adjustable, is supplied. The capacity of this machine, which is made in the usual sizes, is very great indeed, and nearly 50 per cent. more work can be done with it than with the ordinary machine. The working parts are made proportionately stronger, and all screen areas have been necessarily enlarged. Special attention has been given to the lubrication of the drum bearings, and a self-lubricating bearing has been designed. The bearing is not only self-lubricating, but is also adjustable, and, although with the angle iron frame this is not so important, it is still an advantage in case the machine is not set quite accurately, as all danger of hot bearings is prevented.

One of the earliest firms to turn attention to the treatment of Indian corn was Messrs. Clayton and Shuttleworth, of Lincoln, who have been manufacturing machines of this kind since 1866. We are enabled through their courtesy to put two very interesting drawings—page iv.—of their latest design before our readers. The ears of maize are shovelled into the hopper direct from the wagons that bring them up, and are raised by the elevator to the crushing drum, where a beater revolving at a very high speed separates out the grain, which falls through on to the main riddle. This is set at a slight inclination, so that the larger refuse that is unable to pass through it gradually works its way down to a receiver at the end. The grain falls on to a second riddle, and is there subjected to a blast of air which frees it from dust and chaff. It then passes through a bottom sieve, and finally, falling into an elevator, is raised up to shoots at a convenient height for delivery. The shelled cobs and the husks, dust, &c., are delivered at the end under the feeding elevator. The lower half of the elevator is fixed to the other part, so that it can be turned up when the machine has to travel. A suitable support takes the weight of the overhung end when it is in use. Ready means for tightening the conveyor belt are provided. Two sizes of this machine are made, requiring respectively engines of 5 and 6 horse-power to drive them. The smaller has a capacity of about 160,000 lb. of husked maize in ten hours, and the larger of about 230,000 lb. in the same time finished ready for delivery. The output with unhusked maize is about half this quantity. To meet the requirements of small growers, Messrs. Clayton and Shuttleworth make also quite small machines to be worked either by human or animal power.

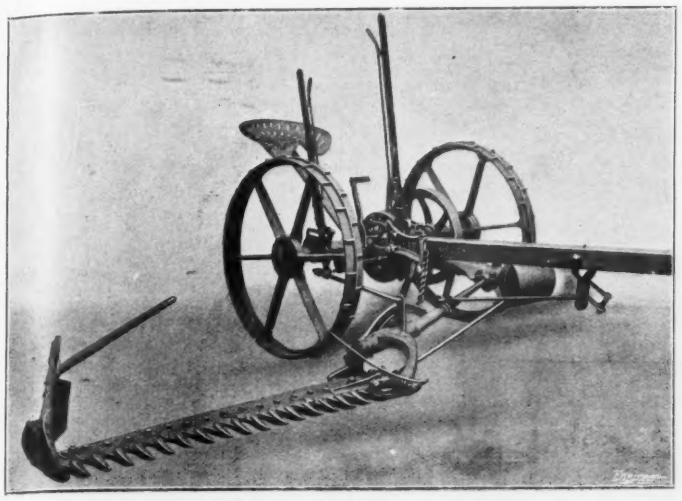
A thrashing machine which will appeal particularly to our colonists of Australia and New Zealand is illustrated on page iv.; it also is made by Clayton and Shuttleworth. This machine is intended for use where "strippers" are used for reaping the corn, and the quantity of grain to straw is consequently great. To meet this circumstance thrashers are made with a shaker extension, or with extra long straw shakers, as shown in the engraving,



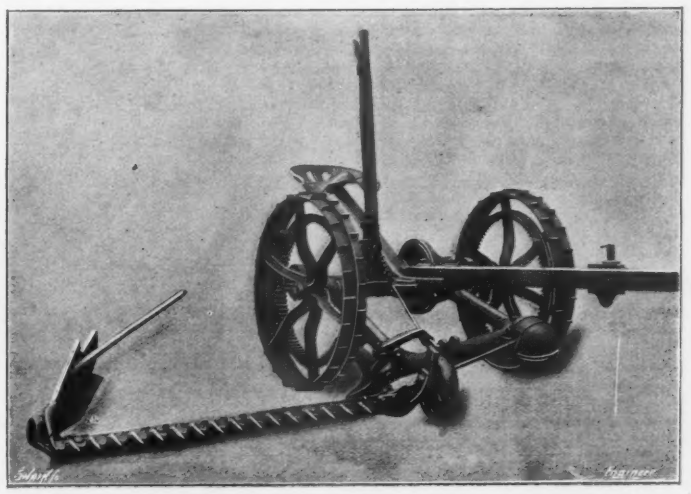
SAMUELSON'S REAPER AND BINDER

whilst the rotary screen is made of larger diameter than usual, and the blowers and riddles are made of the greatest width that the framework will allow, so that the greatest possible area of riddling and screening surface is provided. Straw elevators are not infrequently attached to these machines. The shaker extension consists of a series of wooden prongs placed across the machine below the ends of the shaker boxes; they are caused to vibrate by a connecting-rod. The straw falls off the shaker boxes on to these prongs,

and any grain still adhering to it is separated out, falls on to the shogging board, especially lengthened for the purpose, and is conveyed to the riddles. It is unnecessary to tell our readers who have any experience at all of the work turned out by this firm that everything down to the smallest details in these machines has been carefully thought out. It is safe to say that there is no feature that is generally considered desirable in thrashers which these machines lack, and when we say that, we save ourselves the necessity of detailing the many features which are essential to a first-class machine of this kind.



SAMUELSON'S TWO HORSE POWER MOWER



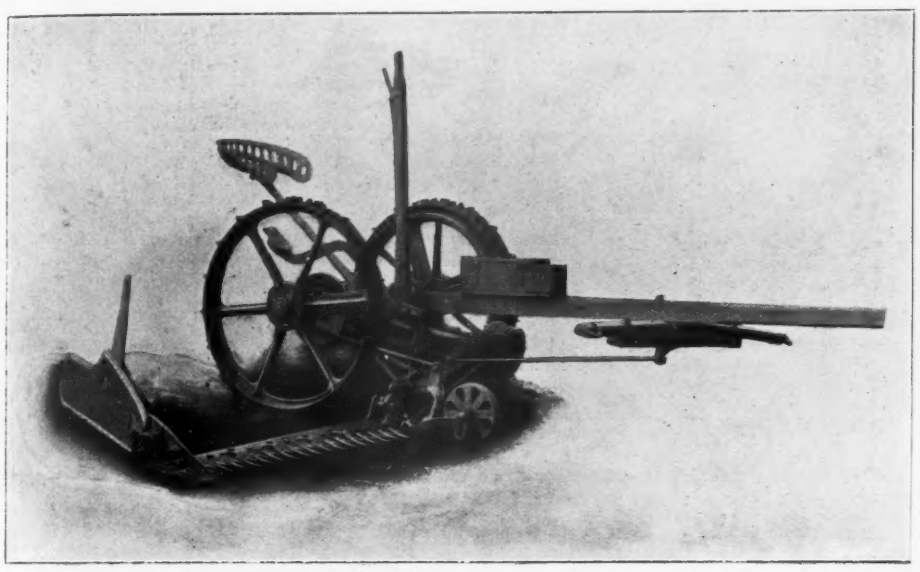
SAMUELSON'S MOWER

STACKING MACHINES.

A few representative types of stacking machines and straw elevators will be found illustrated on page v. Four engravings show two machines of different kinds made by Marshall, Sons and Co., Limited. In order to avoid the troubles to which telescopic elevators were found to be occasionally subject, the two main parts of the troughs in the machines under notice are hinged together, and the upper half is made to turn over and lie on the lower half in a way which will be obvious from the engravings. The arrangement has, furthermore, the advantage that less head room is required for storing, the highest part being only 8ft. above the ground when the stacker is closed. It is also less likely to come in contact with overhanging trees when travelling. Powerful gear for raising the trough and supporting it at an angle is fitted. The maximum height that can be reached with the smaller machines of this type is 25ft., and with the larger machines 28ft. The lifting gear, owing to the use of a worm, is self-locking, so that there is no danger of the trough falling from careless handling. The rake chain is driven by simple gearing by means of a belt passing round two guide pulleys. As these machines are frequently worked in conjunction with a thrashing machine, the driving strap is usually taken from a pulley on that machine; but in other cases, as for stacking hay and clover, or elevating loose corn or sheaves on to stacks during harvest, provision is made for attaching a horse gear.

One elevator is slightly different from the other. It will be seen that the back wheels are on separate axles, so that they can be moved round into the position shown, and the whole machine can then be easily swivelled round the forecarriage. The carrying trough. It is a heavier machine than the others illustrated, but it has the advantage that the carrying teeth are above the straw, and the latter is therefore not blown about by the wind. The angle of the trough can be regulated in much the same way as in the other elevators.

This firm also makes an ingenious elevator which is attached permanently to the shaker end of a thrashing machine and has no wheels of its own. When not in use the trough olds up over the top of the thrasher, and is quite out of the way. It is raised for use by two wooden arms, which are lifted by two wire ropes running in grooved pulleys and hauled in by worm and wheel. When the arms have reached a certain height they are locked, and the angle of the elevator can then be regulated as desired. When the elevator is to be packed up for travelling the procedure is reversed. The top part is drawn up to the wooden arms, and the lower ends of the latter are thrust forward by two levers until the whole thing can be lowered flat on the top of the thrashing machine. A bolt passed through the cover of the shaker from side to side keeps the lower part of the elevator in position. This machine, which we do not illustrate, is made with troughs 18ft., 20ft., or 22ft. long.



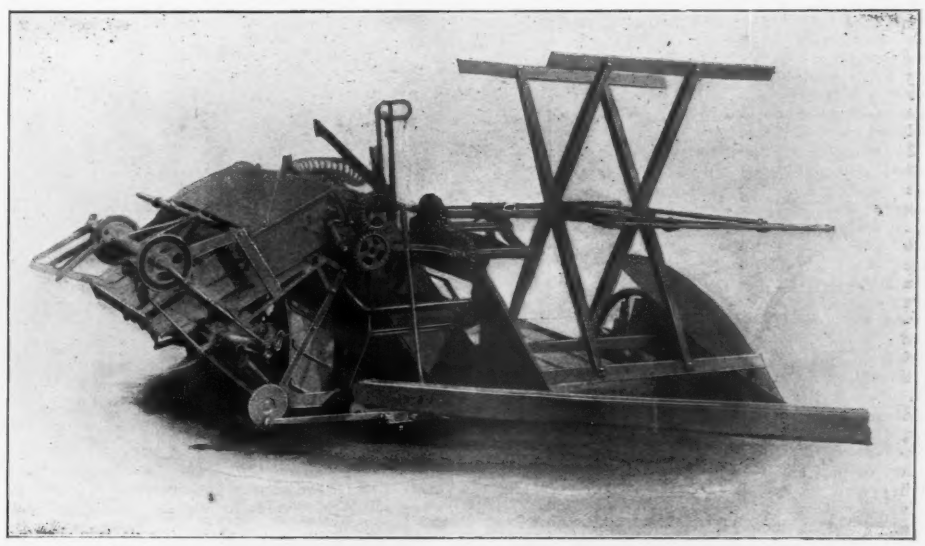
HORNSBY'S MOWING MACHINE

Two other illustrations represent the telescopic straw elevator manufactured by Messrs. Robey and Co., which has several improvements. Among others may be mentioned, that no gear wheels are used; very little power is required, can work in all sorts of weather, can deliver the straw in any direction and at any height up to 25ft., and is made on the telescopic principle instead of the turnover.

MOWING AND REAPING MACHINES.

SEVERAL representative examples of mowing and reaping machines are illustrated in these pages. We do not propose going deeply into the mechanical features of these machines, as to give anything like a full description would occupy more space than we have at disposal, and to the colonist, to whom we hope these few pages will appeal, it is of more importance to know what the machines he has to purchase will do than exactly how they do it.

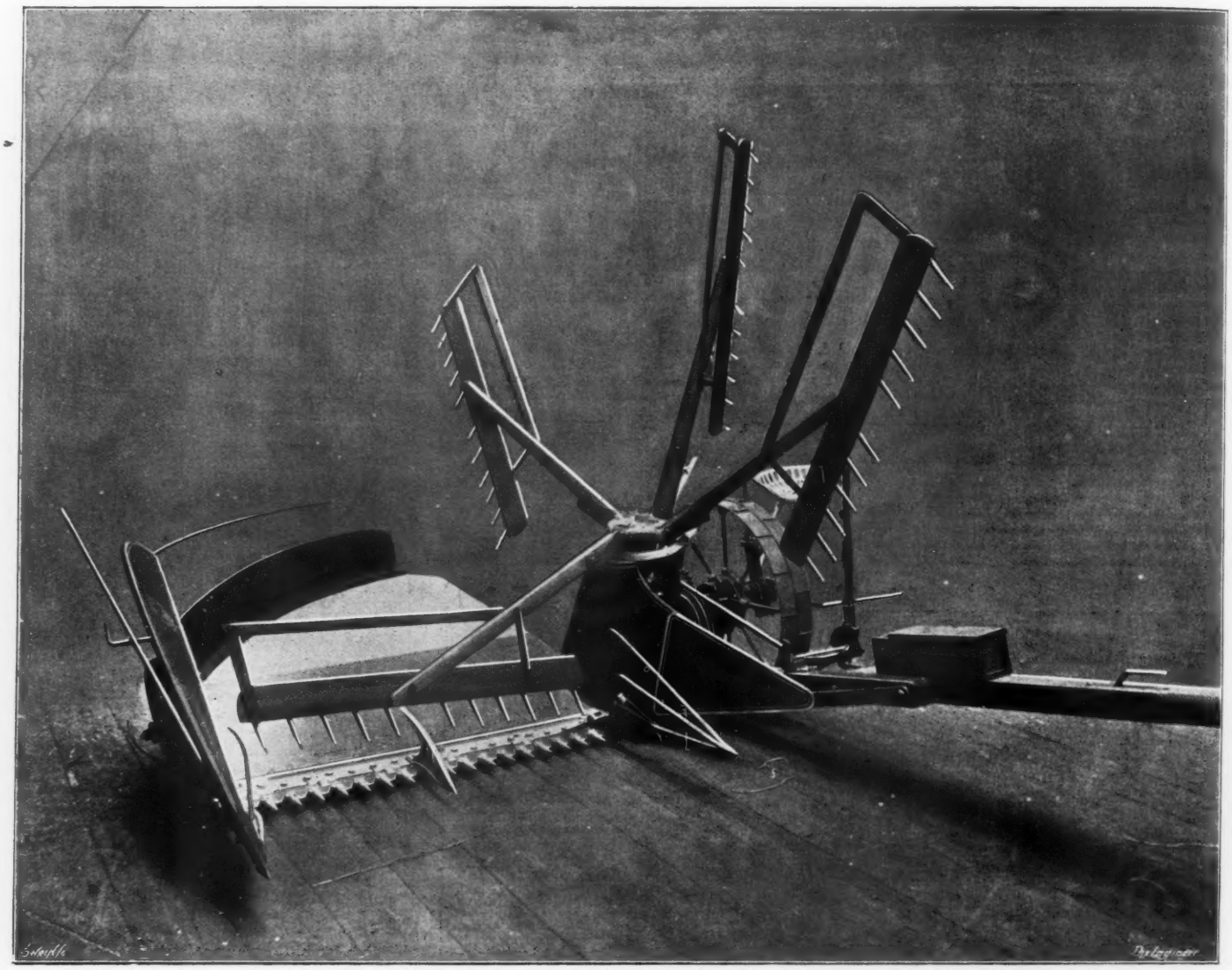
Messrs. Harrison and MacGregor, of Leigh, Lancashire, make a speciality of this class of machines, and have a high reputation. Four of their machines are shown on pages viii. and ix. One is a general view of a mower made by them, and known as No. 9. As will be seen, it is intended to be drawn by two horses, and is made rather wider than the usual practice, in order to make it run more steadily, and to avoid any chance of the horses trampling the swathe. The main frame or casting is somewhat roughly described as tubular, which means that the various shafts run in cylindrical sheaths. They are thus protected from damage, and the machine is given a neat and compact appearance. In order to reduce friction to a minimum roller bearings are fitted to all the revolving shafts. The gearing is very compact. An internal gear



HORNSBY'S REAPER AND BINDER

ALBION REAPER WITH OPEN RAKES

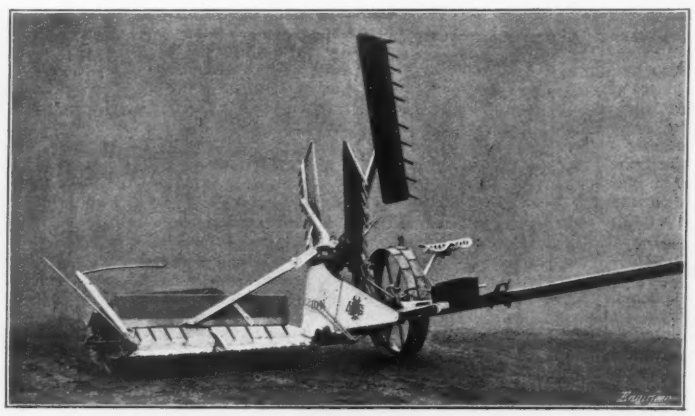
HARRISON, McGREGOR AND CO., LIMITED, LEIGH, MAKERS



wheel is bolted to the driving road wheel and meshes with a pinion keyed to the first motion shaft; a spur wheel also keyed to this shaft drives a pinion, which is one with a bevel wheel whose follower drives the crank shaft. All these gear wheels are close together, but their bearings are of ample length. The bevel wheel and pinion are cast in one piece and bored, the roller bearing on which they run being the whole length of the hub. This bearing is placed lower than the main shaft, so that the crank shaft may pass under the latter and lie almost parallel to the ground. A clutch is provided on the first motion shaft for throwing the gear in and out. The crank is of the disc type, a long connecting-rod extends from the pin in it right across the machine to the knife head slide. The guide for the latter is very well supported, so that any ricking or twisting is obviated. The guide has renewable parts which can be readily replaced when worn.

The fingers are of the double shoulder pattern, and are fitted with interchangeable steel plates. The sections overhang the knife bar, and the knife bears on hardened steel renewable wearing plates. Hand and foot levers are provided for lifting the finger bar, and an adjustable spring counterbalances, to a great extent, the weight of the finger bar on the ground, thus allowing it to follow easily the irregularities of the surface. Close to the hand of the driver is the tilting lever, by means of which the points of the fingers can be raised or depressed equally at both ends of the bar, a useful arrangement when working over very rough ground or cutting a laid crop. The road wheels are provided with four spring pawls, so that no motion is lost and clogging the knives is avoided. All the moving parts that can possibly be so treated are enclosed.

The Albion reaper is illustrated on this page. In the first view it is shown with open, and in the last with full rakes. It has been especially designed for districts where a light and handy machine is required. It takes a cut 5ft. wide. The framework is made wholly of iron, and all the gear is enclosed to protect it from dust and damage. The driver's seat is carried on a side projection, and the lever for throwing in and out of gear is at his right hand. The rakes are controllable, and may be set to deliver a sheaf at every rake, or every second, third, fourth, or sixth rake, whilst by the pressure of the foot upon a lever the rakes may be raised so as to pass over the platform without delivering at all. In order to allow the reaper to pass through gates of the ordinary width the foot support and seat are made to fold back, and the platform is, moreover, jointed, so that it may be turned up for transit. A tipping lever for raising the points of the finger in the same manner as for the mower just described is provided, and also a self-locking crank handle for raising and lowering the machine.



HARRISON AND McGREGOR'S REAPER WITH FULL RAKES

The last machine made by this firm, which we illustrate, is the reaper and binder shown on page ix. The frame of it is made of channel section steel, and the elevator frames are so securely stayed and fastened to it, that there is no binding or twisting of the bearings. A good point about the machine is the way in which the reel is mounted, so that it can be thrown up or down, forwards or backwards, very readily, to meet any condition of the crop.

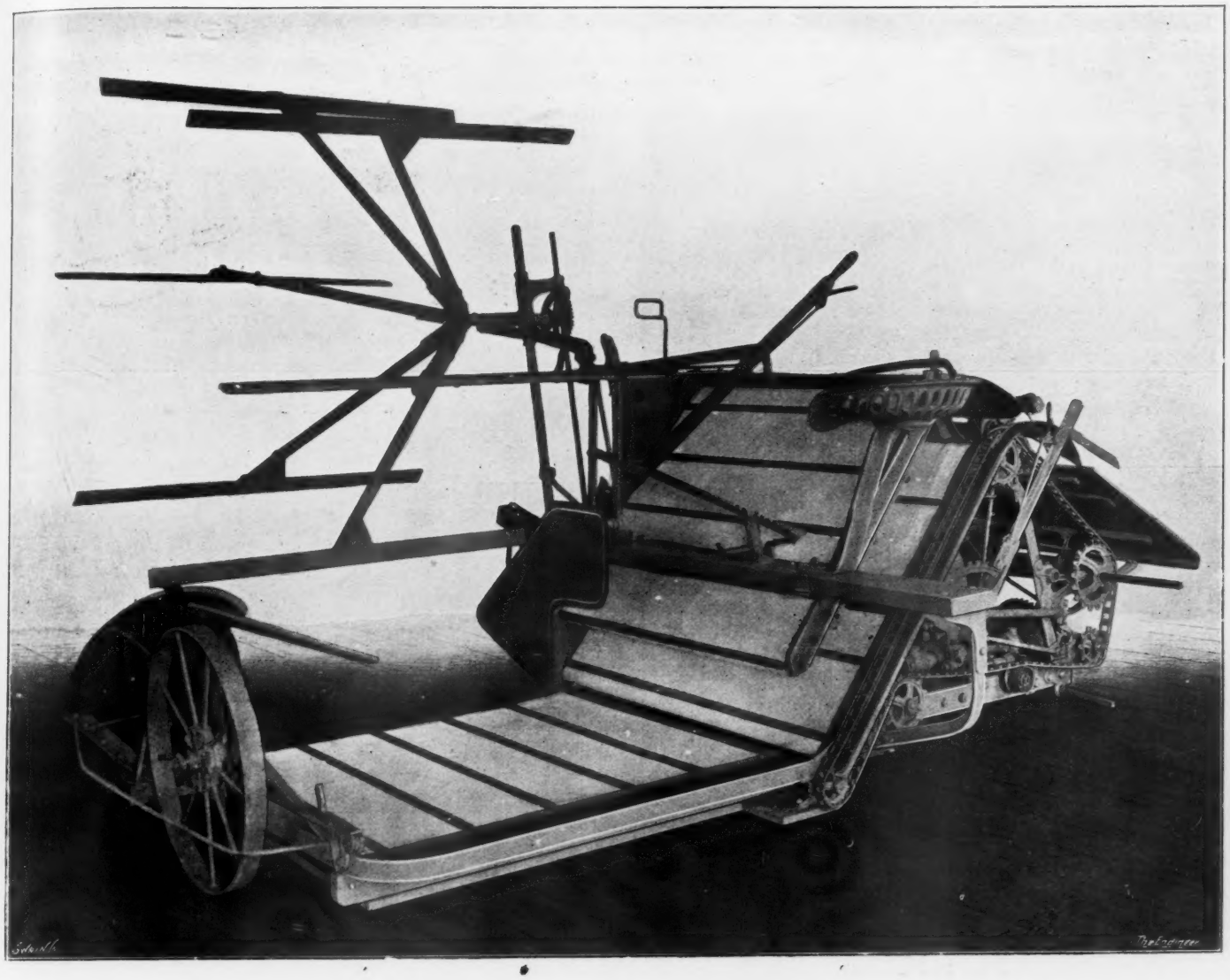
Another well-known firm which makes machines of this class is Messrs. Bamford and Sons, of Uttoxeter; they manufacture a mower particularly suitable for the Colonies. It is a light machine, suitable for hilly and uneven grounds, and is intended to deal with all kinds of crops. The usual internal gear wheel fixed inside one of the road wheels is not used, but a spur wheel is mounted further towards the centre of the shaft, and drives a short train neatly boxed in. The frame is of the tubular pattern, and the wheels are put a good distance apart. Both the main and cross shafts are fitted with roller bearings. It is scarcely necessary to say that there is the usual lever for tipping the fingers. A foot lever for lifting the finger bar over obstacles or when turning corners is also provided. Careful attention has been paid to the lubrication of these machines. The length of the cutter bar is generally 4ft. 6in., but longer bars are sometimes fitted.

A self-raking reaper by Samuelson and Co., Limited, is illustrated on page vi. It has been specially designed for districts where a rather light machine is wanted, and is largely constructed of steel and malleable cast iron. The driver can control all four rakes from his seat whilst the machine is cutting, a lever enabling him to vary the number of rakes, and thus the rate of delivery of sheaves. By removing a pin all the rakes sweep the platform, practically swathing the crop. The finger beam is hinged to the machine, and can be turned up for travelling. The usual levers for altering the height of the cut and tipping the finger are placed in convenient positions.

Two grass mowers made by the same firm are illustrated on page vii. The machines are designed to be drawn by two horses, but in order to decrease the draught the wheels are made of large diameter, and the main axle and bevel wheel spindle run in roller bearings, whilst a suitable ball bearing takes the end thrust on the bevel wheel. In both these machines the gearing is as far as possible neatly enclosed. The form of the swing beam

REAPING AND BINDING MACHINE

HARRISON, McGREGOR AND CO., LIMITED, LEIGH, MAKERS



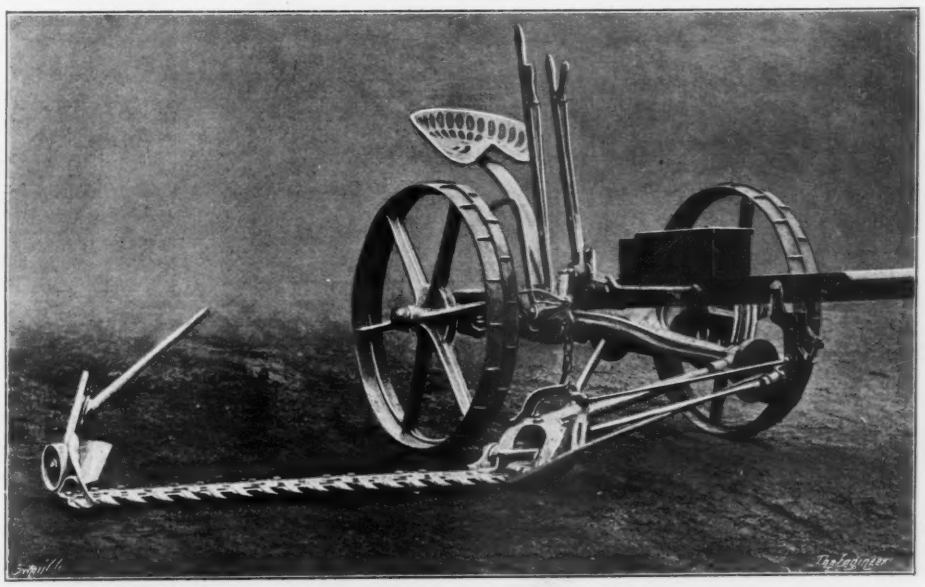
is worthy of attention. It has a ball joint at its inner end, and the connecting-rod being similarly provided, the pitch of the finger is altered without affecting the level of the frame. Both foot and hand levers are provided for lifting the finger bar over obstacles. In these machines the loose pin at the cutter end of the connecting-rod has been given up, and is replaced by a fixed stud.

A reaping and binding machine built by Richard Hornsby and Sons, Limited, of Grantham, is illustrated on page vii.

The main road wheel has a steel plate rim $\frac{7}{16}$in. thick, fastened to two ribs, from which round steel spokes project to the hub. The tire is 9in. wide, and has biting irons riveted to it. On its hub is mounted a large sprocket wheel which drives the first motion shaft by means of a strong steel chain. The binder mechanism is driven by bevel gearing in place of a chain or train of wheels. This machine has a 36in. road wheel, and the usual cut is 5ft., but machines up to 1ft. larger are made. For transport the machine is mounted on a special trolley and is drawn sideways, and can thus pass through narrow gates.

We illustrate also a mower made by this firm. It has either a 4ft. 6in. or a 5ft. cut. Roller bearings are fitted to all the principal journals. The cross spindle is longer than that of the Harrison and Macgregor machine described, and has two sets of bearings in place of one. The connecting-rod has a double joint at the crank pin end, so that the cutter bar may work at any angle. The road wheels are of cast iron, and the cast gear ring fits inside the left-hand wheel, being of nearly the same diameter. It drives a small pinion at a high speed, thus reducing the length of the train of wheels. Both a hand and foot lever are provided for raising the cutter bar over any obstruction. This they do without interfering with the action of the knife.

We illustrate on page vi. a reaper and binder made by Samuelson and Co., Limited, of Banbury. It has a frame made of angle steel, and is of the open-ended type; that is to say, the back of the machine is left perfectly clear, so that the grain, irrespective of its length, can fall flat upon the platform, whence it is conveyed to the binding table. The driving gear is simple, one shaft outside the machine driving the knife by a crank fixed at one end, and the binding gear, canvas and reel by a chain and sprocket wheel at the other end. The reel is under the complete control of the driver, and the inclination of the platform and fingers are also readily altered to suit the conditions. To suit different lengths of straw the position of the binding table can be altered. The buttor is of the reciprocating type.



HARRISON AND McGREGOR'S No. 9 MOWING MACHINE

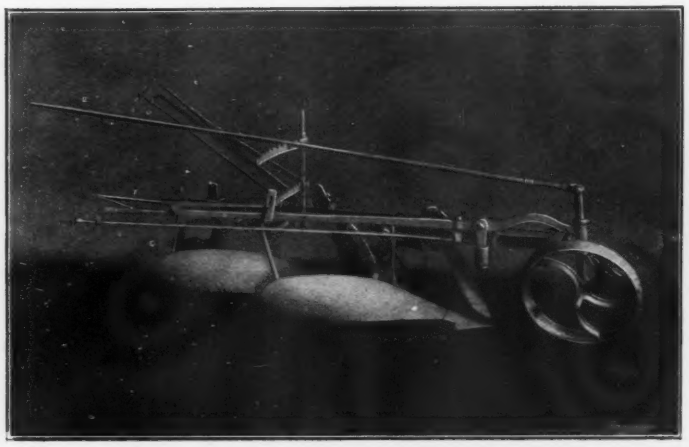
The road wheel is of large diameter, and drives the gearing by means of a chain. Both it and the off-side wheel are adjustable by worm gearing to give any height of cut within limits. These wheels are placed opposite each other, so that the machine may work smoothly across ridge and furrow.

PLOUGHS.

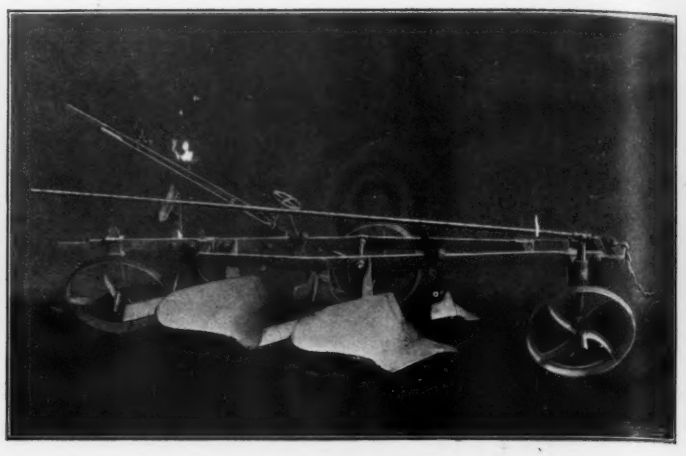
ONLY those who made them have any notion of the enormous variety there is in ploughs and parts of ploughs. It would be no exaggeration to say that more than one of our leading manufacturers of agricultural machinery could put together five or six hundred ploughs which would differ from one another in some main feature. The conditions that have to be considered are of such infinite variety, and the taste of users so capricious, that this astonishing number of patterns is

HORSE PLOUGHS

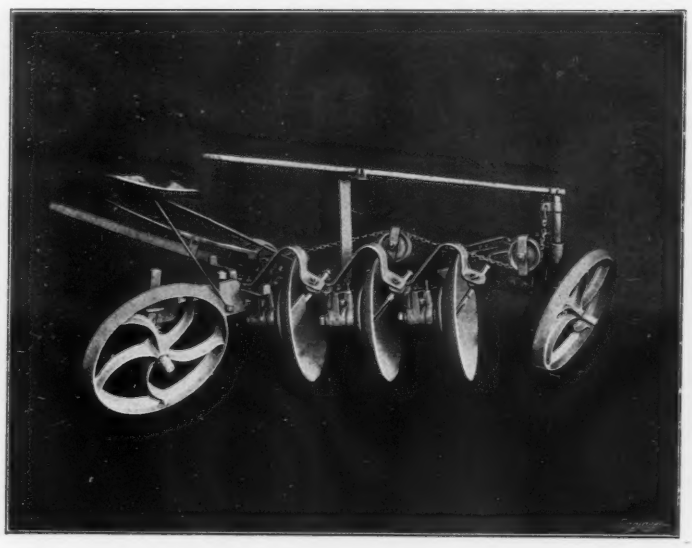
MESSRS. J. AND F. HOWARD, MAKERS, BEDFORD



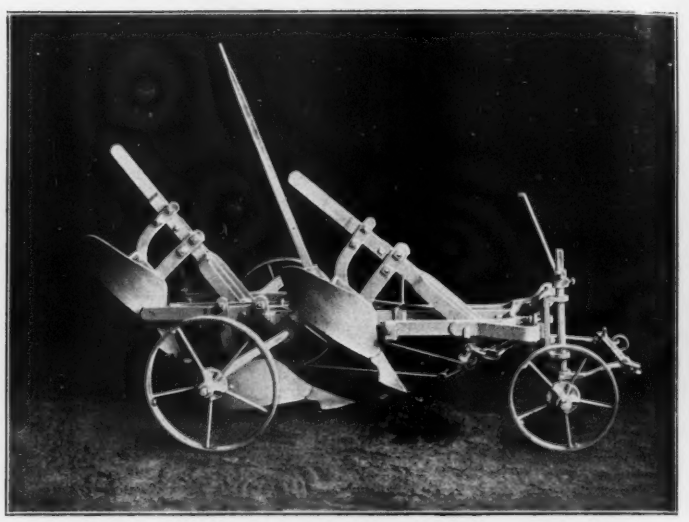
DOUBLE BREAST STEERING PLOUGH



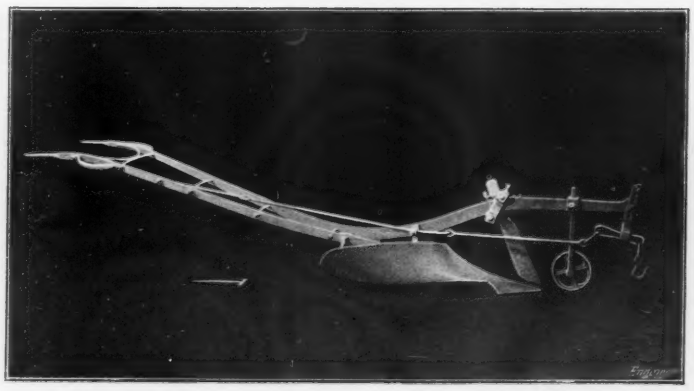
W COLONIST DIGGING PLOUGH



ROTARY DISC PLOUGH



STUMP JUMPER PLOUGH



COLONIST PLOUGH

COLONIST MULTIPLE PLOUGH

not found to be more than enough. The one-way ploughs of Kent, the swing ploughs of Scotland, the wheel ploughs of nearly all the counties of England, and the foot ploughs of Essex are so different that any one not an expert would hardly believe that such differences in an implement for cutting and turning the land could be necessary in so limited an area as the United Kingdom; but this variable climate, and the equally varied soils, necessitate different treatment according to season and crop, and farmers know that the ploughing for clay soils would be unsuitable for light sandy or fen lands.

The emigrants—especially from Scotland—who were the pioneers of cultivation in the great Australasian Colonies and in New Zealand, took with them the implements they were accustomed to use in their own country, and it will still be found that the Scotch type of plough, with long handles or stilts and short beam, has taken a very strong hold in New Zealand; whilst the wheel ploughs of Hornsby, Howard, Ransome, and others were more to the liking of the settlers in Australia.

The Cape, with its predominant Dutch population, early took up a double-furrow plough made for it by Howard in 1846 to the design of one of the resident farmers, and for many years these double-furrow ploughs, with beams and handles of wood, and the shares made on the interchangeable principle, were the favourite implements in the western province of Cape Colony, where the bulk of the cereal crops were grown. In the eastern province the single-furrow ploughs were preferred, and for the use of natives the Eagle plough, a modified form of the common plough of Holland, was used, its cheapness being its chief recommendation. These ploughs were largely made in America, but the quality having deteriorated to meet the very low price offered for them by importers, similar ploughs of British make now command higher prices.

The Colony of Natal having many British farmers, several varieties of ploughs have all along been imported to meet the predilections of emigrants from different parts of the United Kingdom, and to suit the very varied soils and crops grown the sizes and patterns of ploughs in use are numerous.

The annual shows of the agricultural societies of South Africa have enabled farmers to see and to select new implements and to keep themselves well abreast of the times. The ploughs now most in use in Natal are improved Eagle ploughs, and double and triple-furrow ploughs, first introduced in 1876 by the late Mr. James Howard when he took out to South Africa the veteran ploughman, John Hulatt, to show the Dutch the advantages of these new implements.

The Orange River Colony uses a handy double-furrow plough made specially by Howard, which until the war was known in South Africa as the "Vrijstaater," but now known as "The Orange." The Transvaal uses single and double-furrow ploughs of the "Chucker" type, which make broken work similar to that done by the Howard original digging ploughs.

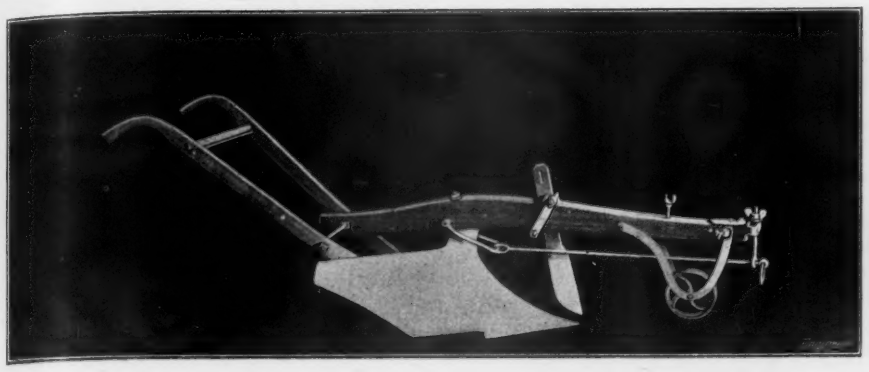
Stump jumper ploughs, so largely used in Australia in bringing scrub land into cultivation, have been tried in South Africa, but have not found favour. Generally speaking, the older cheap crude ploughs are giving place to more costly but more durable implements, which

accomplish more work with less manual labour and fewer oxen.

In lands where oxen are chiefly used for draught everything goes at the same slow pace, but where horses are used, as in Australia, the work is got over in less time, and a more advanced and progressive type of implements is demanded. No black labour being available, the white man works, and, his time being more valuable, a larger area of work must be done in a day to keep down the average cost per acre, hence the multi-share ploughs, wide harrows, cultivators, drills, and disc ploughs are used wherever the land is of an easy-working character; but for stiff soils, deep ploughing, and breaking up virgin land, the implements are of the ordinary English type with modifications, such as are seen in the photographs of the New Zealand double-furrow plough, as shown opposite page 272 of Professor Wallace's book on the "Rural Economy and Agriculture of Australia and New Zealand." Tillage implements with seats are in demand in some colonies, but they are not in general use.

beam it has a tubular steel beam. A third implement of this kind is the little ryot plough made by Messrs. Ransome, Sims, and Jefferies, of Ipswich, and illustrated by C. It is hardly to be regarded as suitable for colonists, but is interesting as being probably the smallest representative of its class. It weighs only 25 lb., and is drawn by a small ox, and is carried from and to work on the shoulder of its owner, the ryot or peasant land owner of India. Its price is exceedingly low.

To jump from small to big, we illustrate two or three-furrow ploughs for deep cultivation on heavy land, and strong enough to be drawn by many pairs of oxen or horses; and to go further, the huge ploughs made by Fowler, of Leeds, for steam traction. Between these extremes are to be found, as we have already said, an enormous variety of patterns, some of which will be found illustrated on pages x. and xii., and need little more explanation than that afforded by the descriptive titles under the engravings. A single-furrow plough, by Ransomes, Sims and Jefferies, is shown by D. It has a long breast,



A.—HOWARD'S COLONIAL PLOUGH WITH WOOD BEAM

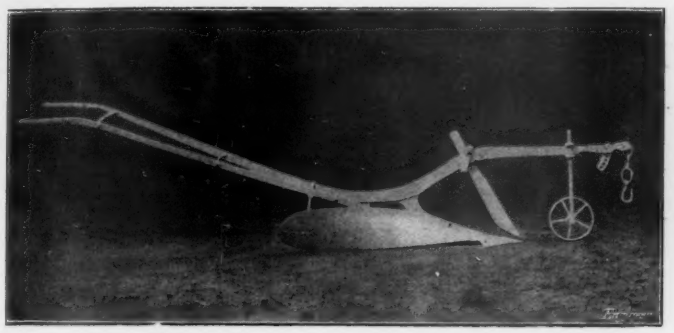
STEAM CULTIVATION.

WE do not know who made the first machine worked by steam for cultivating the ground. It is known, however, that James Watt contemplated something of the kind. Indeed, as soon as the rotative steam engine was produced ingenious men invented a multitude of uses for it, and it was not likely that stirring the soil would be omitted.

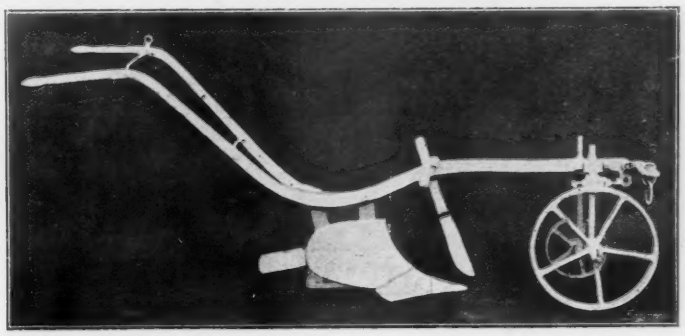
It is no disparagement to other men, however, to say that steam cultivating as the world knows it originated with the late John Fowler about the year 1855, and as far back as 1858 the late John Smith, of Coven, built for him an under-drum ploughing engine, which represents the system of haulage now almost always adopted. This engine had long leaf springs to the driving wheels, side frames, and inside cylinders like a locomotive, and a locomotive type boiler. The crank shaft propelled the engine by a pitch chain. A great deal of experimental work was done with this engine near Wolverhampton. It would be waste of space to go deeply into the history of steam ploughing. We have mentioned in another page the names of several of the more important inventors. The system as it now is is an excellent example of the survival of the fittest. It has been developed by the aid of an enormous expenditure of capital. At one time it appeared as though nothing could be made of it. The late Duke of Sutherland, who was at heart an engineer, took the matter up and applied steam ploughing and cultivation on a great scale in reclamation works on one of his Scotch estates, and the success which was attained helped to make a system popular which that most conservative of men, the British farmer, regarded with doubt as a new-fangled notion such as his father had never heard of. The result of all this is that the modern steam plough and its developments are represented as a whole by the firm of John Fowler and Co., Limited, of Leeds. Other makers supply engines and tackle, but there are no practical constructive differences. All modern steam cultivating machinery is made on the same lines, the difference being in details.

There are two principal systems of steam ploughing—namely, the single engine and the double engine. The mechanical operation to be effected in each case consists in hauling the implement which moves the soil back and forward across the field to be ploughed. Under the single-engine system a travelling anchor is laid on one headland and the engine takes up its position at the other. The wire rope is long enough to pass round a large horizontal sleeve or snatch-block on the anchor and return to the engine. The plough is secured to that side of the double line of rope that runs directly to the winding drum. It will be seen that it is only necessary to make the engine haul on the plough side of the double rope to pull the plough towards the engine. If the engine is then reversed, so as to pull on the other side of the rope, the plough will be hauled towards the anchor. Under the engine is placed a large horizontal pulley called a clip draw. Its grooved ram is built up on a most ingenious system, invented by Mr. Fowler, of clips which automatically grip the wire rope, and automatically release it as it becomes tangential.

The plough is double. Its construction is illustrated



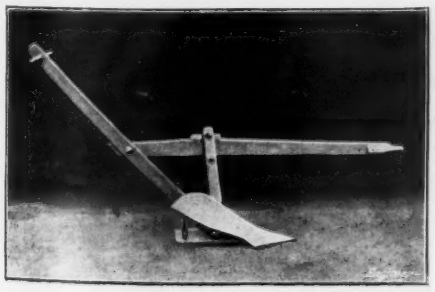
D.—RANSOME'S SINGLE FURROW PLOUGH



E.—RANSOME'S DIGGING PLOUGH

The Chinaman who supplies vegetables for the coast towns in Australia likes a cheap, light plough, costing from 30s. to 40s., whereas the governor steerage double and triple ploughs cost almost as many pounds.

Obviously we cannot illustrate or describe anything like the whole gamut of changes roughly indicated above, but we shall select from a few makers a dozen or so examples which may be fairly taken as representing the kind of ploughs which our home makers are prepared to supply to the Colonies. A great deal has been heard, both from our own correspondent in South Africa and

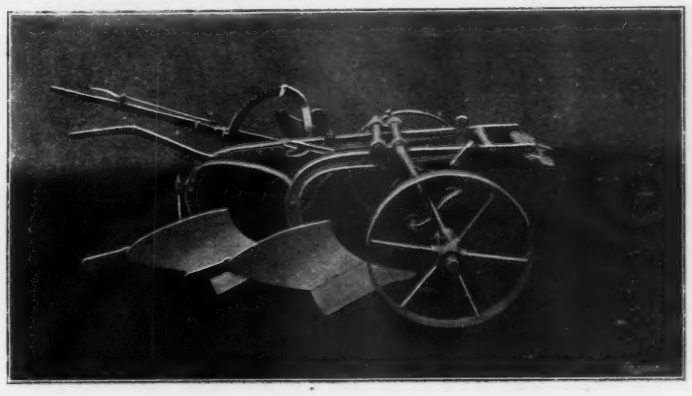


C.—RANSOME'S RYOT PLOUGH

from other sources, of the need of a very cheap instrument to contest the popularity of the American plough. We illustrate, therefore, on this page and page xii. three of the cheapest forms made by three different firms. That illustrated in A is made by James and Frederick Howard, of Bedford, and very closely resembles the American plough, about which so much has been heard, both in price and appearance. It has, it will be observed a wood beam. The second plough—B, page xii.—is made by Richard Hornsby and Sons, Limited, of Grantham, and is intended to replace the old Eagle, for many years the popular colonists' plough. In place of the wooden or mould-board, for turning an unbroken furrow slice, whilst E illustrates a light plough with a short abrupt breast for producing broken or digging work. A double-furrow plough made by the same firm is shown in F. It has a device, originally designed by the firm, for lifting the shares out of the soil at the end of the furrow. An apparatus for sowing maize is often attached to these ploughs, the seed being dropped into the furrow and covered by the front ploughing body. These ploughs are fitted with the self-sharpening share, patented as long ago as 1803. The under part of these shares is as hard as steel, whilst the upper part, though tenacious, is comparatively soft, and hence wears away more quickly than the lower part, consequently leaving always a sharp cutting edge.

Representative ploughs, made by Richard Hornsby and Sons, Ltd., are shown on page xii. They are mostly made of steel, and are practically indestructible, even by the white ant! A cheap, light allotment plough is shown whilst the heaviest and strongest plough of this kind is also shown. A double-furrow plough is illustrated, and a single plough with a semi-digging breast and double rubbers is represented, and also a ridging plough.

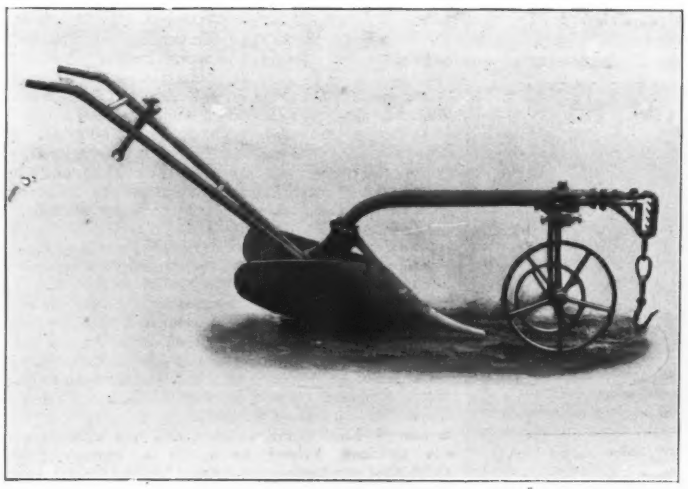
A series of implements of this kind, made by J. and F. Howard, of Bedford, are illustrated upon page x. These ploughs are all the result of extended experience and they are produced by special machinery. It seems impossible that any other country could produce a greater variety of ploughs for every possible need



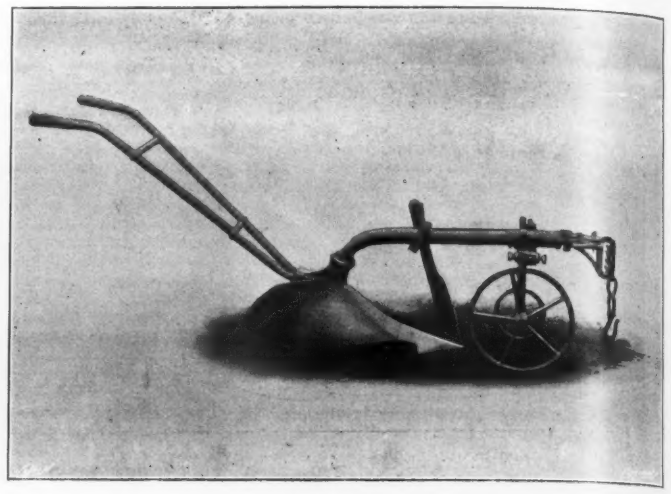
F.—RANSOME'S DOUBLE FURROW DIGGING PLOUGH

HORSE PLOUGHS

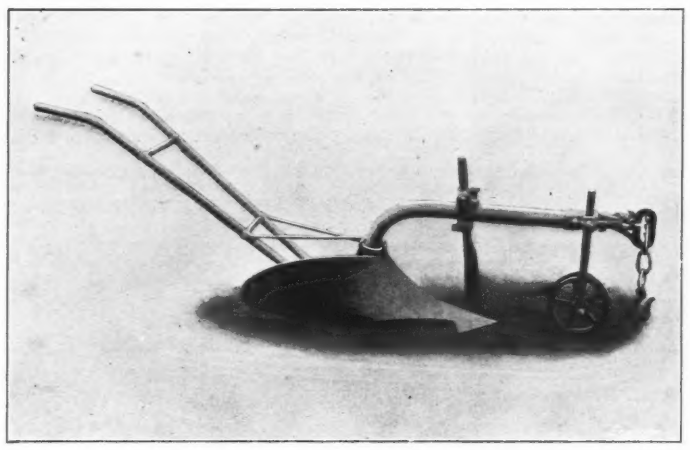
RICHARD HORNSBY AND SONS, LIMITED, GRANTHAM, MAKERS



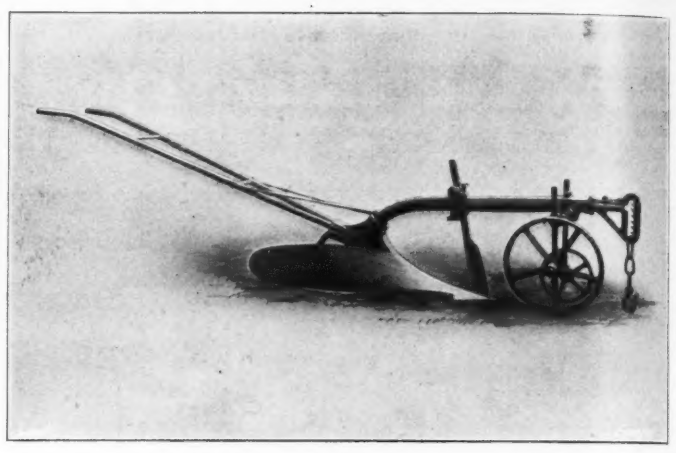
RIDGING PLOUGH



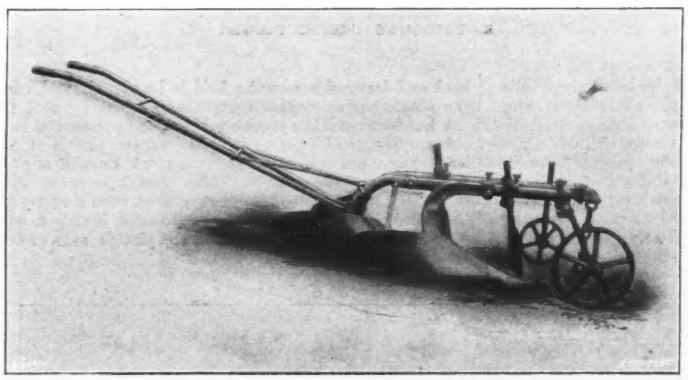
PONY PLOUGH



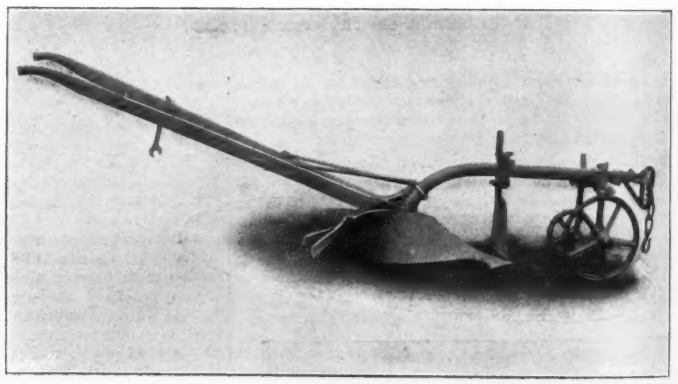
B.—COLONIST'S PLOUGH



HEAVIEST TUBULAR BEAM PLOUGH



DOUBLE FURROW PLOUGH



SEMI-DIGGING PLOUGH

on page xiv. One set of breasts is raised into the air while the others are in the ground. At the end of the bout the positions are reversed. This obviates the necessity of turning the plough round at the end of each bout. As a strip of land some 5ft. or 6ft. wide is ploughed at each course or bout, the engine is moved through that distance along the headland on the completion of one course, and the anchor is moved an equal distance at the next stroke. Most ingenious mechanism has been devised for making the anchor shift itself. The snatch-block, for example, has been made to impart motion to a small drum, which, winding in a rope at right angles to the plough rope, hauls the anchor ahead when a clutch is put in gear. Again, however, we have the survival of the fittest. The modern anchor consists of a wrought iron frame, carrying, as we have said, a horizontal sheave, and resting on dics wheels, which cut into the ground, and resist the side stress of the engine and implements. The wheels have broad tires as well as the discs to prevent the whole sinking too deep. It is moved along the headland by the direct pull of the hauling rope, and provided with tines, which prevent any forward motion of the anchor until they are lifted by the rope. This is done automatically each time the implement comes up to the anchor, which moves forward until the winding is stopped. The advantage of this anchor is that the ploughman, without leaving the implement, can control the distance it moves forward each journey, and it requires no attention, being entirely self-acting. It is provided with a steerage, which enables it to be worked along a crooked headland.

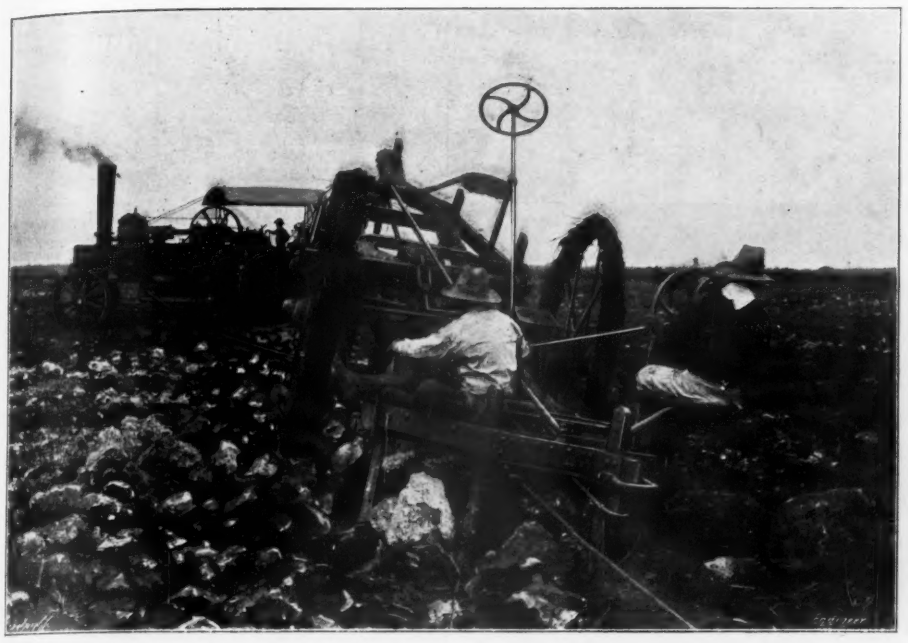
In the modern modification of the single-engine system, the engine is fitted with two winding drums on the same vertical shaft, under the engine, instead of a single clip draw. These are run alternately in opposite directions, one paying out while the other hauls in. The rope is then laid as a rectangle along the sides and ends of the field. Two anchors are used and one corner snatch-block, and the implement travels backwards and forwards between the anchors and not between one anchor and the engine. It will be seen that, simple as all this seems at first sight, many stiff mechanical problems had to be solved. One of these consists in always keeping the tail rope taut. Mr. Fowler invented a most ingenious compensating gear for this purpose, which was in some cases fitted to the implement and in others to the anchor.

Time would fail us to record the hundreds of inventions made and patents taken out by the Leeds firm, of which inventions but a few survive.

Not the least interesting feature of the whole scheme is the part it played in the construction of portable, or, rather, self-moving engines. The nominal 8 horse-power thrashing machine portable engine would develop about 12 horse-power at a push, and weighed about 2 tons empty. It was very soon found out that this style of engine was useless for ploughing. Aveling and Porter, of Rochester, were bringing to perfection a traction engine. The Steam Plough Works, Leeds, working on the same lines—in some cases joint patents were taken by the late Thomas Aveling and David Greig—made ploughing engines of a size and power quite unknown. They raised the boiler pressure from 50 lb. to 150 lb., and their construction culminated in engines weighing 16 tons each, and developing with ease 120 indicated horse-power. These engines were an entirely new departure in road work; engines of much less weight supplied the most usual demand, and 50 to 60 indicated horse-power will plough wheat land at the rate of an acre an hour. Mr. Aveling being asked once what part of the ploughing plant broke most, replied "everything." Mr. Smith's foreman, Robert Dodd, said that "whenever wi' went ploughing wi' always took horse and cart wi' us to fetch pieces hoame." Part after part was strengthened; at last steel came to the assistance of the engineer. Only those who have seen a couple of the great ploughing engines made by the Leeds firm taking up their station after doing a bit of steeplechase work across country on a winter's day can realise the stresses that have to be and are sustained. We give on pages xiii. and xiv. two pictures that will serve to convey some idea of what

the steam plough can do. They will serve to show that great force has to overcome great resistance, and we are reminded by them of the old Greek *crux*, "If an irresistible force encounters an insurmountable obstacle, what will happen?"

For our present purpose we do not think it is necessary to write at any length about steam cultivation for British farmers. Something may be said which will be of advantage for those who have land to reclaim, and for that purpose steam stands out of all proportion of merit above every other means of moving the soil. Thus, for example, otherwise good land is oftentimes afflicted with stones. An example of what the steam stone lifter will do is given above. On page xiv. is shown the way in which land is broken up to a great depth to prepare it for the growth of vines and orange trees. In the West Indies for sugar estates drainage furrows have been opened, 3ft. wide at the top, 1ft. at the bottom, and about 3ft. deep, at one stroke. The plough was hauled by an engine indicating 120 indicated horse-power, a single-purchase block being put in to double the hauling effort, the speed of the plough being halved.



FOWLER'S ROCK LIFTING STEAM CULTIVATOR

We cannot, however, better put the facts before our readers than in the following report by Mr. J. R. Cox on the reclamation of the Oued-Mendel marshes:—

"The marsh which I undertook to drain in 1899 was situated 28 kiloms. south-west of Algiers and 7 kiloms. north of Boufarik. The marsh had an area of 750 acres, of which 500 belong to Mr. J. Holden, and 250 to Mr. Debonna.

"The marsh was the cause of all the malarial fever in the district. To drain the marsh, the Government had made a canal running from east to west and emptying into the Mazafran. Messrs. Holden and Debonno, so as to establish the limit of their properties, and at the same time draw the water away from these low lands, had also made a canal running from north to south, and joining the canal made by the State. In spite of all these works, the water of the numerous springs being unable to flow anywhere, remained on the surface, and the marsh was constantly increasing. It was becoming a danger which had to be stopped.

"It was impossible to cut the reeds and weeds, which attained a height of 5ft., because it was exceedingly dangerous for men to venture on such a quagmire where a number of oxen had already perished. Owing to these difficulties it was not possible to see what work should be done for draining off the water. I therefore resolved to try with my Fowler's engine what results could be obtained. The plough being pulled by the rope of each engine, all that was necessary was to place the engines at a suitable distance from each other, and to make in front of each a road, which, while rendering the scheme practicable, would afterwards serve as a farm road.

"At first the ploughman thought they would never be able to do the work. Twenty times during each bout the plough had to be pulled back, so as to get it out of a hole. The land was turned over in bands, about 10 yards in length, all in one solid piece, owing to the sticky nature of the soil and to the weeds; the large wheel of the plough was running in water. It was exceedingly trying for the ploughmen, and the plough time after time had to be deviated from the straight course, so as to avoid a hole too big or too deep.

"Every furrow was full of water, but I was careful to make a ditch at each end. These ditches, whilst running along my engine roads and draining them, received at the same time the water from the furrows, which formed so many drains.

"The soil was thus drying naturally, and I was enabled to see the state of the ground where the springs were, and also the low parts, so that I could make the necessary draining ditches.

"All the work was executed with Fowler's ploughing engines, and one of their single-furrow deep balance ploughs, the whole material giving entire satisfaction. The first year oats were sown, and a splendid harvest was obtained in these lands which hitherto had never produced anything.

"A great difficulty was experienced in advancing the engines forward. As I have previously stated, it was arranged that the passages for the engines would afterwards serve as roads; and with this in view I filled up in front of the engines all the holes that were found with stones, pieces of wood, &c., and when it was impossible to pass, or that time was wanting for filling up a hole, the engine was made to travel a little further out on the side, and the ploughing was made with a lengthening piece added to the rope.

"Of course, the work was not perfect. The weeds choked the plough, sometimes lifting it even out of the ground, while occasionally the plough disappeared in a hole, and we had to take it out with the greatest care, but every furrow made was a drain, taking away so much water. Most offensive smells emanated from the land, and it was only due to the strong hygienic precautions enforced on the men that the latter were prevented from taking the malaria. The harrowing was done the first year with a Fowler's steam harrow, but the implement suffered very much owing to the large lumps made by the plough when it had turned over that sticky, soaked ground.

"The second year the work was executed with more facility; good roads existed, but it was still very hard work for the plough. A layer of land about 8in. to 10in. deep was completely dry, but the bottom part of the ground was still wet. That second year, the work having begun late in the season, the engines were blocked by the rains in the ploughed ground, and it was with the greatest difficulty that we were able to get them out.

"Last year—1902—the harvest has been made with a reaping and binding machine, which amazed the great number of visitors who had come to see it done, and who had known the marsh and shot wild duck on it; but another result obtained, and which, in my opinion, is most important, is that fevers have been completely stamped out of the district. Last summer, after the harvest, I took up the work again, and a certain part of the land has been ploughed with a three-furrow plough, but I have only been able to do the well-dried parts. As soon as we met with damp ground the three-furrow plough sunk and choked, and we had to use the single-furrow plough again. For such work it is necessary to take the least possible depth, and lift the plough as high as possible; the ground being damp causes the plough to sink deeply—unfortunately, more deeply than is wanted too many times.

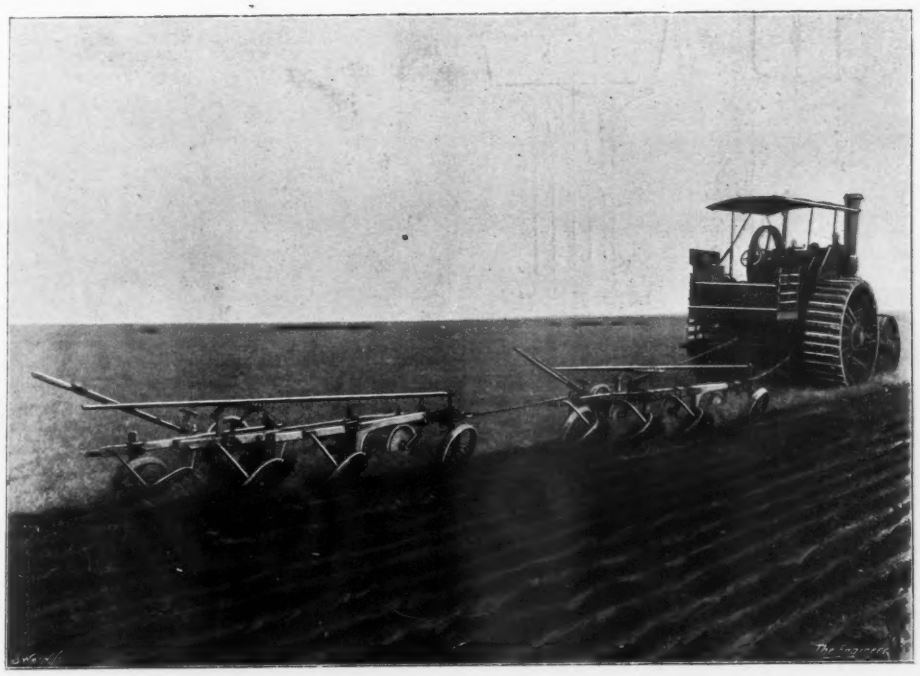
"In a piece of 100 acres I have planted vines. They are growing splendidly, and the land is completely dry. I must add, in conclusion, that the proprietor who undertakes work of this importance must consider neither time nor money. It is very costly, and it is most necessary to enforce on the men employed the greatest hygienic precautions. But what are the expenses compared with the results obtained?

"Thanks to my Fowler's steam-ploughing tackles, I was able to render salubrious a large area of land which was pestilential and of no value whatever, and which has since acquired a certain value. Last summer—1902—I undertook the same kind of work at Saint Charles, another estate belonging to Mr. Debonno, and the results obtained have been most satisfactory for the first year."

This report, we think, is convincing evidence of what steam cultivation can do. It now plays a most important part all over the world, and it is equally at home on the veldt of South Africa, in the corn lands of England, the beet farms of Germany and France, and the sugar-cane fields of the West Indies. As it is, it is the result of arduous labour for half a century; and we think we may say that mathematics, thermodynamics, nor even entropy has had anything whatever to do with a result of which British engineers may be proud, for steam cultivation is wholly an English product of mechanical engineering.

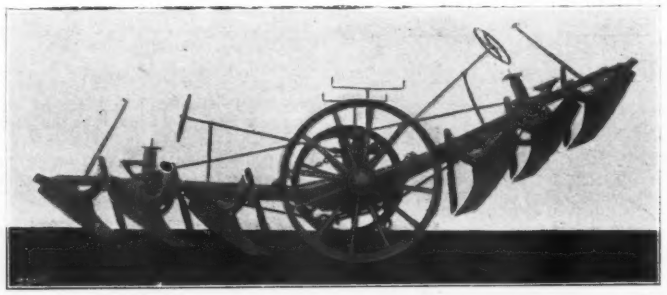
PORTABLE AND TRACTION ENGINES.

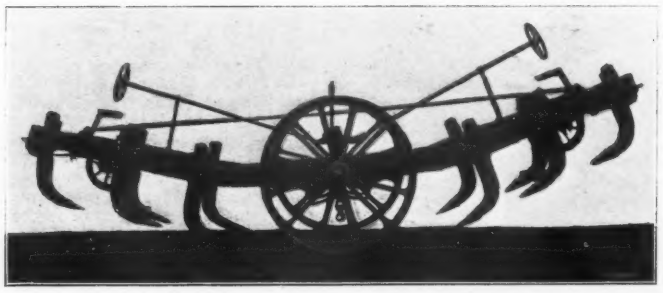
It would have been easy to fill all the pages at our disposal with illustrations and descriptions of road locomotives and traction engines, and for the very reason that there was more material to our hand than could be well dealt with, we have decided not to illustrate engines at all. But the question of straw-burning is of such very great importance in our Colonies—far greater importance than British farmers find it easy to realise—that the present Supplement would be incomplete if some mention were not made of the special devices that are employed for this purpose. Straw-burning gear is, of course, far from new, most of our leading portable engine builders having adopted some type or other many years ago. A few examples of furnaces and the all-important spark-arrester are illustrated by the annexed diagrams. Robey and Co., Limited, of Lincoln, make a special straw-burning portable engine for the Colonies. Our readers are well acquainted with the particular feature which has now been adopted by several makers of mounting the cylinder and crank shaft bearings on steel brackets riveted to the boiler, and thus avoiding the necessity of using bolts passing into the steam space. This is an excellent arrangement. The cylinder and crank shaft bearings are held together by stays, but the latter are left free to slide, so that the alignment of the engine is not affected by the expansion of the boiler. Four different kinds of spark-arresters are made by Robey's, and are illustrated by the following sections:—A shows the ordinary spark catcher, with copper gauze wire at the upper end to prevent the emission of sparks. The chimney is provided with a cover, which can be lifted to facilitate the raising of steam. B shows the



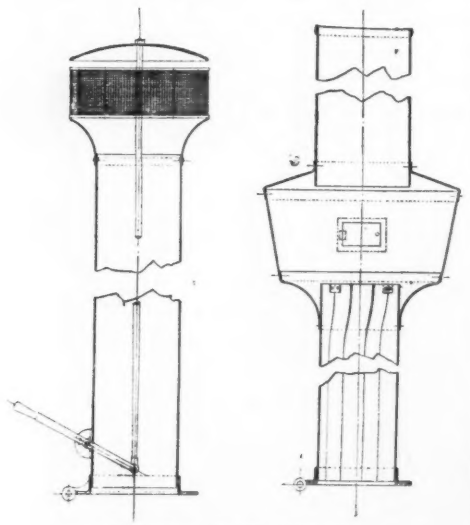
DIRECT HAULAGE GANG PLOUGHING

system adopted in several countries of giving the sparks a whirling motion, by which they are driven into the enlarged chamber, and there come to rest, and are extinguished. This chamber can be cleaned out by means of a door provided for that purpose. C shows the system of allowing the sparks to strike against the baffle plate at the top, causing them to fall into the chamber at the side. A movable cover is also provided to facilitate the raising of steam. D shows the water spark catcher, by means of which the sparks striking on the baffle plate at the top are plunged into the water, which is lifted into the reservoir by means of suitable connections to the feed pump. These portable engines are made suitable for using all kinds of fuel; but in most of the Colonies and abroad straw is used, and the illustration E shows the newest design of straw burning furnace. This system is a combination of the Elworthy and Head and Schemioth apparatus, the internal arrangement of the furnace, page xv.—but the Elworthy furnace has only a hopper in place of the usual fire door. The baffle, too, is very different to the curved plate of the former system, consisting of three cast iron plates, which rest on an angle iron riveted to the front tube plate. There is also a movable grate with a deep, open ashpan underneath it. Schemioth's curved baffle is supported on a crossbar, and can be swung into its most efficient position. The spark arrester adopted by Garrett is also shown. It consists simply of a series of baffles. It is made under Graham's patent. By lifting

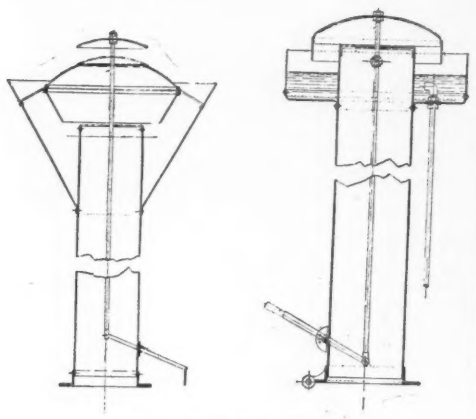




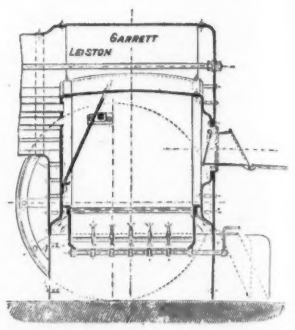
FOWLER'S STEAM PLOUGH AND CULTIVATOR



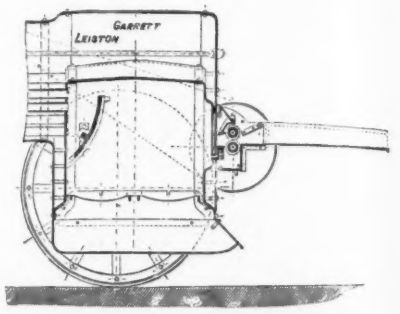
GARRETT'S SPARK ARRESTER



GARRETT'S SPARK ARRESTER

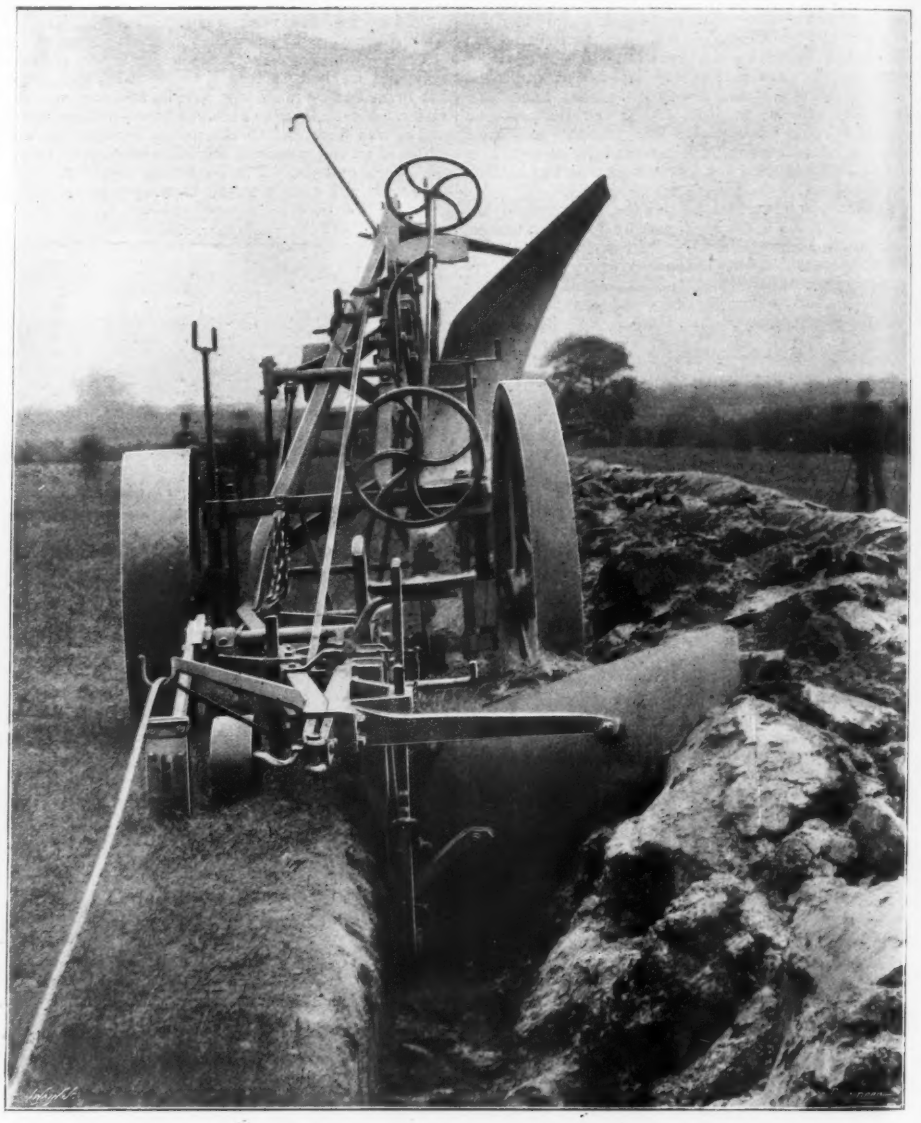


GARRETT'S STRAW BURNER



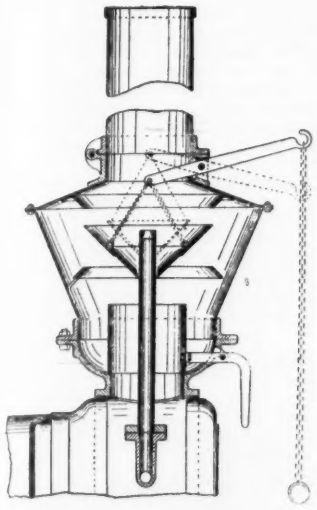
GARRETT'S STRAW BURNER

practically given up, and Schemioth or Elworthy's forms are more generally employed, because they are more easily stoked. The particular variation of these furnaces, as made by Garrett's, are shown above. Schemioth's furnace has an automatic feeder—see also Robey's



FOWLER'S PLOUG PREPARING VINE LAND

the lowermost baffle the collected dust is allowed to fall into the smoke-box.



GRAHAM'S SPARK ARRESTER

Whilst portable and traction engines are under consideration, Charles Burrell's name cannot be left out, and if it were our purpose to trace the history of this branch of engineering, a position in the front rank would have to be given to the Thetford firm. They have been building road locomotives for about fifty years, and at one time constructed the remarkable engine designed by Boydell. This engine, many of our readers will remember, carried, so to speak, its own road with it, battens or shoes being loosely attached to the wheels in such a way that they came flat on the ground just in time to receive the wheel, and were lifted up again when the wheels had passed. These engines were employed at one time for drawing multiple ploughs by direct traction on the land. That, however, is a side issue. Now-a-days Messrs. Burrell make a great variety of road engines, and among them a couple for colonial use—one for burning coal or wood, and the other for straw or similar refuse. Some time ago we illustrated their colonial road locomotive in these pages. It has a compound engine, and the fire-box is made of extra size for wood fuel. In the smoke-box a series of baffle plates and screens is fitted to trap all sparks, and no other arrester is necessary. The tender is lengthened, and has racks for carrying wood. The ashpan is of special design, and a little water is always retained in it to extinguish ashes and avoid the risk of setting fire to the long grass over which the engine may be expected to run; and, to meet the rough ground of virgin colonies, the wheels are made larger than is customary, so as to raise the engine higher from the surface. The engine is mounted on springs, and is powerfully geared. It is frequently fitted with extra wide wheels to adapt it for ploughing by direct traction.

SMALLER IMPLEMENTS.

Lest it should be supposed that it is only to implements of the larger and more imposing kind that British makers of agricultural machinery turn their attention, we give a few—a very few in relation to the great number that is made—examples of the smaller implements that are made in this country. One of our biggest makers of this kind of machinery are Ransomes, Sims, and Jefferies, of Ipswich. An ingenious potato-digger made by them is shown in the next column. It is a very simple implement. The curved blade, going under the tubers in the row, lifts them up. Then the wheel, armed with tines rotating, knocks the potatoes to one side out of the soil, leaving them clear to be collected into baskets. The work is done at about 2½ to 3 miles an hour.

The Ipswich cultivator, which is also made by the same firm, is intended to work in very hard soil, and will prepare a seed bed in addition. It can, indeed, be fitted with seed boxes, so that it sows at the same time it cultivates.

In Messrs. Ransome's patent Star horserakes the teeth are made of steel, of T section, and the patent side levers, which serve to raise or lower the teeth, can be instantaneously adjusted to the required height. The work of discharging the load is exceedingly light.

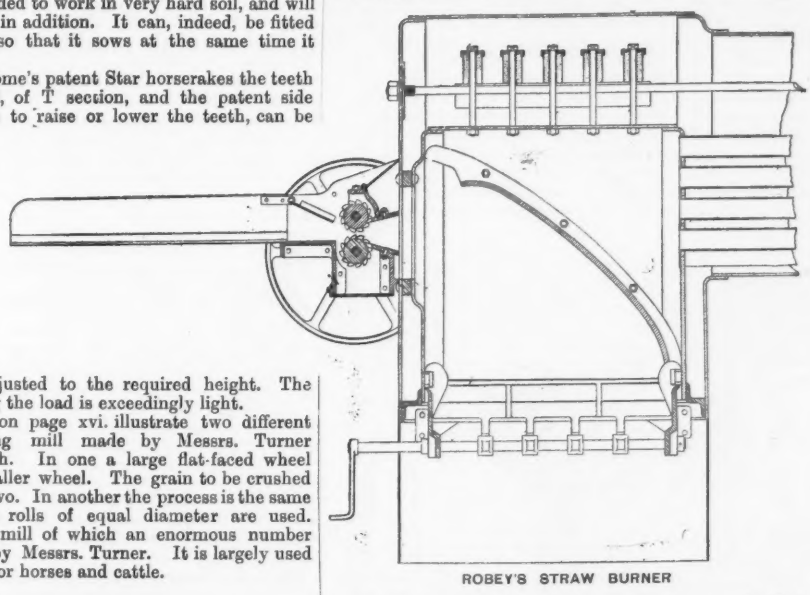
The engravings on page xvi. illustrate two different types of crushing mill made by Messrs. Turner and Co., of Ipswich. In one a large flat-faced wheel runs close to a smaller wheel. The grain to be crushed falls between the two. In another the process is the same in effect, but two rolls of equal diameter are used. This is a type of mill of which an enormous number have been made by Messrs. Turner. It is largely used in preparing food for horses and cattle.

BRITISH MACHINERY IN CANADA.

(From a Canadian Correspondent.)

THE outlook for British manufactured farm machinery in Canada, though not particularly bright at present, is certainly reassuring. The Canadian farmer requires a good article, and does not object to the cost so long as he is satisfied with the result obtained. There is no demand for goods of the *cheap* variety, and British manufacturers should bear this in mind when catering for colonial trade, in Canada at least.

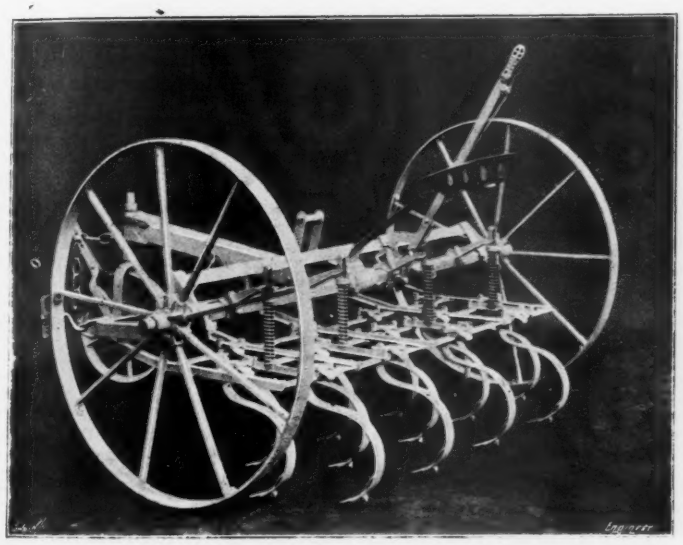
There is, however, a large and ever increasing demand for up-to-date and trustworthy implements, scientifically constructed, and built with the idea of meeting and supplying some particular need; but they must be placed on the market in competition with machinery of Transatlantic manufacture. The British maker is the very man who can turn out such goods, if he will only by personal investigation make himself familiar with the immediate needs of the Canadian farmer, and then apply that knowledge to the manufacture of goods adapted to meet the requirements.



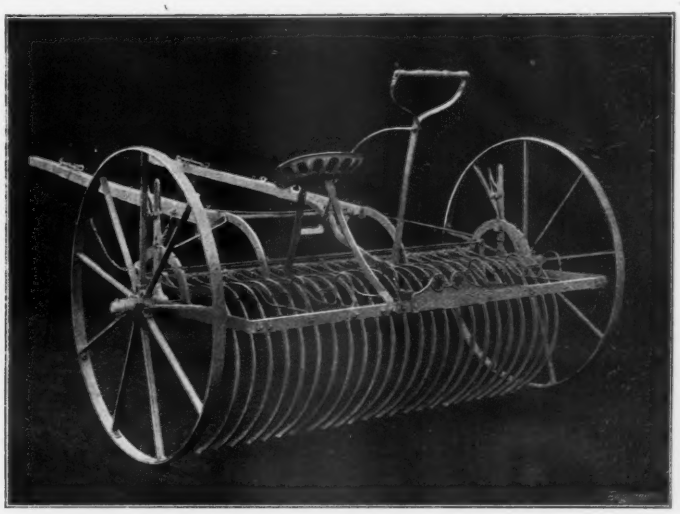
ROBEY'S STRAW BURNER

In some localities there are British-made ploughs at work, and good work they do, but the owners complain that the draught is heavier than that of Canadian and American made ploughs of the same class.

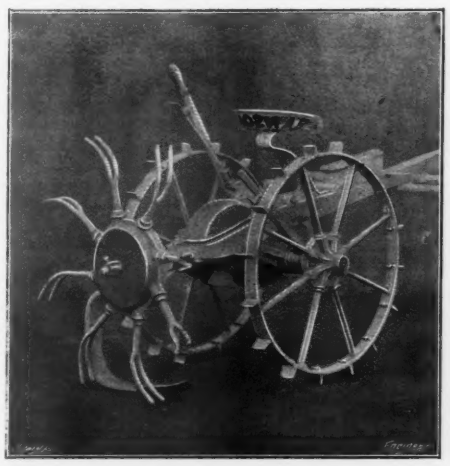
There is no reason why this should be, and the home maker, if he likes, can put a plough on the Canadian market which in point of workmanship, durability, construction, and cost, will hold its own with any other.



RANSOME'S IPSWICH CULTIVATOR



RANSOME'S STAR HORSERAKE



RANSOME'S POTAT DIGGER

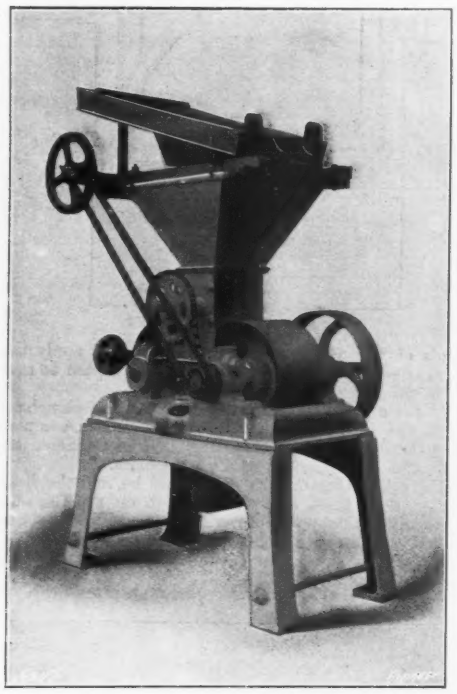
With regard to other things, such as harrows, cultivators, &c., the same remarks apply, and though we have in Canada several farm-implement makers, there is always room on top, and there is nothing to hinder large British makers who wish to extend their trade area establishing themselves in Canada—a young and growing country, and one, as far as the great West is concerned, essentially agricultural—retaining their own ideas with regard to strength, durability, and good workmanship, but acquiring the newest, best, and most modern thought to secure lightness of construction and draught, combined with the capability of performing certain kinds of work well; taking every advantage, by being on the spot, in the way of cheaper raw material, lighter ground rents and taxation, and turning out a class of goods manufactured with that accuracy of construction in every detail which characterises British made goods all over the world. In the consideration of any great trade question it is necessary to look at things as they exist, and no amount of talk will persuade Canadians to buy machinery not adapted to their circumstances, consequently the man is successful who sees what the trade demands and gets it first into the market. I have been asked frequently to what extent steam is superseding the horse in the ploughing of prairie and stubble, and the answer has been that farmers, as yet, have not gone in for steam ploughing, as the cost of keeping the engine supplied with water, fuel, and attendance makes the price prohibitive, and while steam is used entirely for thrashing, &c., it will not replace horses for ploughing the land.

There is, however, an idea that motor ploughs, properly made, and simpler in construction and management than at present, may, in the not far distant future, come into general use in the level stretches of prairie with their "league-long furrows." Certainly there is much to be said for them, and it only requires a little more careful

thought on the part of our great scientists and practical mechanics to bring motors within the reach of every one who uses motive power to any extent.

There is room, however, for a steam engine plant, and makers of this class of machinery should bear this in mind. The resources of the Dominion have been, and are still being, taxed to their very utmost to keep pace with the demand for steam engines for thrashing, cutting wood, grinding grain, &c. Western Canada is developing at a wonderful rate, as will be seen by comparing the total yield of grain in 1891, 16 million bushels, with 116 millions in 1901, and in order to keep the farmers supplied with power for thrashing, large supplies of engines have been imported from the United States.

I am speaking now of portable and traction engines of



TURNER'S CRUSHING MILL

14 to 22 horse-power, and as the fuel in thrashing time is in the West entirely straw, they must be fitted with straw burners.

There is a growing demand, too, for 8 to 12 horse-power portable engines, as many farmers are deciding to go in for a smaller outfit of their own instead of being at the mercy of the travelling thrasher and waiting till he can get around. In some instances two or three farmers go in together and have a thrashing outfit between them, thus becoming independent of anyone else and doing their work when they like. British manufacturers should have a first-class chance for this trade, as they certainly excel in making motive-power plants.

My impressions from the point of view of a Canadian farmer lead me to this conclusion. Canadian farmers require large quantities of farm machinery, British makers wish to extend their trading area, and there is no reason why the latter, under proper conditions and making goods to suit the customer, should not capture a large share of the trade, and obtain a foothold to await future developments, thus making profit to themselves and incidentally cementing those bonds of love and sympathy and brotherhood which must ultimately lead to the federation of the greatest empire the world has ever known.

AGRICULTURAL MACHINERY FOR SOUTH AFRICA.

IN spite of what has been written to the contrary, Great Britain holds a larger proportion of the market for agricultural machinery and implements in South Africa than she does in almost any of her other important possessions.

South African trade statistics at the present day are an unsatisfactory guide, owing to the upsetting influence of the three years' war and the scramble which has ensued since. The only figures we will quote here are those for the year 1900, for goods mostly ordered before the war actually took place, and at a time when anti-British feeling was at its height.

Doubtless, as the war was in full swing at the time when these goods were delivered, there must have been a good deal of cancelling of orders and postponement of delivery. This will account for the small value of the imports in that particular year. It may be fairly assumed, however, that the proportions from the various countries were normal. The figures relate only to the imports into Cape Colony, but include goods passed through that Colony to the inland Colonies:—

Imported from.	Machinery.	Implements.	Hoes and Picks.	Total.
	£	£	£	£
Great Britain ...	22,833	36,288	95,710	160,672
British Possessions...	259	339	5,243	
Belgium	216	584	— ...	800
France...	—	36	— ...	36
Germany	425	15,002	1,350 ...	16,777
Holland	12	85	— ...	97
United States ...	22,253	22,938	— ...	45,191
Other countries...	—	6	— ...	6
Total ...	45,998	75,278	102,303 ...	223,579

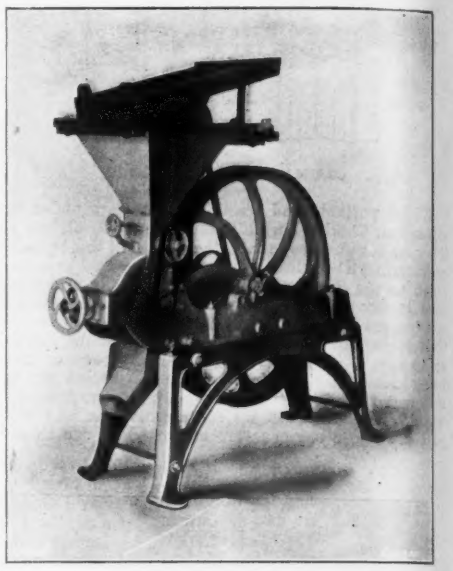
It would seem, therefore, that as far as agricultural machinery, implements, and tools are concerned, out of the £223,579, Great Britain and her Colonies supplied goods to the extent of £160,672, or about two-thirds of the total. That is how matters stood at the beginning of the war, and the position was satisfactory.

It remains to be seen how matters now stand, and that cannot yet be ascertained with accuracy. Many superficial writers have made sweeping statements as to the inefficiency of the methods of our British manufacturers in carrying on their trade policy in South Africa. Now, while there is but slight foundation for these and many other statements of a similar nature, there is no doubt that, as far as engineering firms are concerned, the British maker of agricultural plant has before him a more severe fight than almost any other. He has to fight in South Africa the battle which he has fought, and in a large degree lost, in Canada, Australia, and New Zealand. He has to face a country—the United States—whose huge agricultural requirements are greatly in excess of those of Great Britain, and whose manufacturers have in consequence a far larger local field than have ours. The agricultural conditions of the United States, too, bear a much greater resemblance to those obtaining in the Colonies than do ours. The result is obvious. The American manufacturer falls naturally into making appliances which are suitable and cheap. It is for our manufacturers, if they consider it worth their while to make for export to the Colonies, not what is most suitable for home requirements for the sort of domestic farming of England, but plant which is suitable for colonial work. There is a popular assumption that our manufacturers have taken no steps in that direction, but while, no doubt, they might do more, it is certain that many of our more important firms have recently been devoting a great deal of their attention to this point.

On this particular question we communicated with our Special Commissioner in South Africa, and he wrote to us as follows: "I have met half-a-dozen of the representatives of British agricultural machinery firms out here since the war, and they seem to me to be perfectly alive to their interests. Though, as far as stocks are concerned, among the lighter tools those of American make are much more *en evidence* than are ours, there is undoubtedly a very large and steady trade in the British article. I have seen many recently imported ploughs of British make which are, to all intents and purposes, identical with the popular American designs, though usually better constructed. We evidently cannot quite get down to the American prices, but, I believe, that with careful pushing we could counteract that influence if the goods are better in quality. You must discount the rumours of the enormous orders that are being placed in America for these and other goods. Recently I saw a notification in the papers, cabled over to this country, to the effect that one American firm had secured one order for ploughs, which, if true, would mean that this one order represented about 50 per cent. more money than all the orders from South Africa placed in the United States for all agricultural implements in any preceding year. It is hardly necessary for me to tell you that no importing firm out here has heard of such an order being placed. There is no doubt that the American 'No. 75 plough' is at present the standard article for South Africa, and that it is ordered in very large quantities. It remains to be seen whether our manufacturers can afford to make it at the price. It is sold in Johannesburg to the user for less than £2, after carriage has been paid on it from the port at the rate of not less than £6 per ton. I fancy, in fact I am sure, that the Americans and Germans have both been rather severely bitten at times by a little too much misplaced enterprise. British makers hold the field in steam and oil engines for agricultural purposes, and also in traction engines, threshing machines, winnowers, turnip and chaff cutters, and root and maize crushers. I should say, however, that we are losing ground in harrows, rakes, and other kindred tools, and are out of it altogether as far as windmills are concerned. As for hand tools, to my surprise I have found that these are nearly all British."

There is one condition which has militated against our trade in agricultural plant in Canada, Australia, and New Zealand, which does not exist in South Africa. That is, that while Canada adjoins the United States, our chief competitor, she is herself also a large producer of these goods. In a less but increasing degree Australia and New Zealand also make their own machines. Such is not the case in South Africa, where the cost of labour and material will be sufficient to make local production an impossibility for many years to come. For this reason, and because up to the present agriculture in that vast territory has hardly been developed at all, South Africa should gradually become by far the most important market in the world for agricultural plant. In fact, it is difficult to place a limit to the possibilities of the country in this way.

Although the Cape Government sets its face against encouraging the British farmer, the demand for machinery



TURNER'S CRUSHING MILL

is steadily increasing, for the simple reason that even a retrogressive policy is insufficient to stop the natural progress of this industry. Natal is capable of looking to her own interests in this respect, and her country districts are becoming more thickly populated, and her lands developed. In the conquered Colonies Lord Milner is moving heaven and earth to advance the agricultural interests. Land is allotted to settlers, and implements and other necessaries are supplied to them on easy terms. Railways are being specially constructed to tap existing agricultural centres and to open up new ones, and generally speaking, British South Africa is gradually coming to the conclusion that if she is to live and thrive it is essential that, in a measure, she must learn to feed herself. The time has, therefore, come for our manufacturers of agricultural plant to strain every nerve to secure the South African market.

There is, of course, something to be said for the alarmist, and in the course of wholesale and generalising abuse, however unjustified, one can usually find something which is worthy of consideration. Our manufacturers as a rule are not sufficiently careful in their methods of packing. It is not that they do not spend enough money on it, but that they do not pack systematically and with foresight. If by careful management three machines can be packed in a case which does not bulk more than a badly-designed one which will only hold two, a saving of 50 per cent. in freight, which has to come out of somebody's pocket, can be effected. Also, on the above basis, in a warehouse of a given size, you can stock 50 per cent. more machinery. Then, again, in South Africa, apart from the voyage out, agricultural machines have to travel sometimes 1000 miles or more by railway, and possibly another 50 or 100 miles by road. They will be subjected to rough handling. There may be months of delay, and if the bright parts are not adequately protected the goods will be damaged by rust. One authority suggests painting these goods in pretty colours, and, childish as this may sound, there is something in it, for your Kaffir is but a child, and your Boer but little better. There are many apparently trivial points of this sort, which in reality are worthy of serious consideration.

THE CHEMICAL CONGRESS.

(From our own Correspondent.)

No. I.

THE International Congress for Applied Chemistry, which met at Berlin from the 2nd to the 8th of this month, was the fifth of these Congresses, the first having been held at Brussels in 1894. The second Congress, in 1896, had Paris as its meeting place, while Vienna was honoured by selection for the third Congress in 1898, and Paris again entertained the Congress in the Exhibition year, 1900. Three years have therefore elapsed since the last meeting was held, but it is probable, though not yet definitely settled, that the Congress will become in future a triennial fixture. Professor Otto Witt, the President this year, contributed a special article to the issue of the *National Zeitung* (Berlin) for May 31st, which described the aims and objects of these Congresses. A brief summary of the leading points in Dr. Witt's article will be useful in introducing this account of the meetings at Berlin, to readers of THE ENGINEER.

After referring to the well-worn adage that science does not recognise political boundaries, but is truly cosmopolitan in its sympathies and aims, Dr. Witt gave his reasons for believing that the International Congress of *Applied* Chemistry would not share the fate of the abortive International Congress of *Pure* Chemistry, but would continue to flourish, and grow both in membership and importance as the years passed on. The list of sections and papers presented in the second portion of this report gives some idea of the wide field covered by the phrase "Applied Chemistry"—and Dr. Witt referred to this feature of the Congress, and to the remarkable extent to which chemistry penetrated every activity and industry of modern life, to prove that his hopes for the future of the Congress were based on substantial ground. The growth of international trade in chemicals, and in products that were sold by chemical tests was next referred to, and the need for the adoption of uniform and international methods of analysis in the industries interested in the manufacture and sale of these products was urged. Dr. Witt pointed out that the Paris Congress of 1900 had appointed a committee to deal with this most important subject, and that the consideration of this report would be the chief work of Section I. of the present Congress at its first sitting on Wednesday, June 3rd. The appointment of standing Committees to frame regulations and laws of an international character is regarded by many as the most useful work performed by these International Congresses—and Dr. Witt believes that this side of the work will become of increasing importance.

The Berlin Congress of 1903 has been numerically a great success. The membership has far exceeded expectations; and whereas 1500 members were expected to attend its deliberations, and this estimate was actually used as basis of the social and other arrangements, the attendance is stated to have reached 2600. When one remembers that practically the whole of the members are chemists engaged in some branch of the teaching or practice of applied chemistry, this figure is striking and significant.

The official opening meeting of the Congress took place on Wednesday morning, June 3rd, in the large Assembly Hall of the Reichstag Building. The hall was crowded in every part, and probably over 1500 members were present at this inaugural general meeting. Prince Frederick Henry of Prussia represented his Majesty the Emperor, who was away from Berlin attending an important choral festival in Frankfort, and Count von Posadowsky and Dr. Studt represented the State Authorities.

The President of the Congress, Dr. Otto Witt, Privy Councillor and Professor, presided at this meeting, and proved once again his qualifications for the difficult post to which he had been elected. An imposing presence, a good voice, and the ability to express oneself equally well in French, German, or English, as the occasion requires, are characteristics not often met with in one and the same personality, but Dr. Witt possesses all these qualifications developed to an exceptional degree. This opening meeting of the Congress was occupied chiefly by speeches of welcome from the State and municipal authorities, and by the public reception of the delegates at the Congress from foreign Governments, and from foreign scientific societies. As these delegates all spoke in their native tongues, the occasion was one which called forth a striking variety of language and mode of expression. The delegates of the French and Italian Governments—Professor Henri Moissan, of Paris, and Professor Paterno, of Rome—received the most cordial welcome from the assembly, and throughout the whole Congress week. Professor Moissan has undoubtedly been the most commanding and popular figure. How far the demonstrations of German admiration for Professor Moissan have been dictated by personal rather than by political considerations it would be difficult to say; but once or twice during the Congress week political sympathies have certainly been allowed to influence important decisions of the Congress, and have proved that scientists are not yet risen to the full heights of cosmopolitanism described in Professor Otto Witt's opening address.

One of the most interesting functions of the week was the presentation of the Hoffman and Liebig gold medals to Professor Ramsay, of London, and to Professor Moissan, of Paris, for their valuable discoveries in connection with argon and fluorine respectively. These medals were presented by the Deutsche Chemische Gesellschaft and by the Verein Deutsche Chemiker at a special combined meeting of the members of these two societies held at the new Hoffman House, Berlin, and the function was in every way a great success.

Limits of space will not permit of any detailed account of the second general meeting of the Congress on Friday morning, June 5th, when Professor Moissan, Sir William Crookes, and others, gave addresses on subjects which have been made peculiarly their own, or of the third and final general meeting of the members on Monday, June 8th, when, after an exciting discussion, in which some political feeling was manifested, the proposal to meet in Rome rather than in London for the next Congress was carried by a vote of 294 against 274—or by a majority of only 20 votes.

A similar reason also prohibits any detailed account of the social functions of the Congress week, which included an official banquet on the Wednesday evening in the Zoological Gardens, a reception at the Rathhaus by the municipal authorities on Thursday evening, a gala performance at the Royal Opera House on Friday evening, and an excursion to the chain of lakes near Berlin, known as the Wannsee, on the Sunday. All of these functions were attended by the full number of members permitted by the invitation, and were quite successful.

No detailed mention can be made further of the visits to works and manufactories planned for the Saturday. Practically all the important works and factories situated in or near Berlin, of interest to members of the Congress, threw open their doors on this occasion, and members who were able to take full advantage of all their opportunities in this direction, would undoubtedly learn much from their visits.

Passing now to some account of the real work of the Congress in the eleven sections into which it was divided, I must note first that an immense amount of material was provided for the edification or consideration of its members, and that no fewer than 456 papers and reports were planned for reading before the various sections. It is evident that only a very small proportion of these can be dealt with in this report of the Congress—and therefore, in what follows, mention will only be made of a few of the papers which may be supposed to have special interest for readers of THE ENGINEER.

REPORTS OF SECTIONAL MEETINGS.

Section I., under the presidency of Professor Dr. G. von Knolle, of the Charlottenberg Technical School, had a programme arranged for it of fifty-three papers and reports relating to Analytical Chemistry Methods, Apparatus, and Instruments. Space does not admit of detailed reference to any of these, though some of the subjects dealt with would no doubt prove interesting to readers of THE ENGINEER.

Section II.—The Inorganic Chemical Industries, had as president Dr. A. Heincke, Director of the Königl. Porcelain Manufactory in Berlin, and thirty-nine papers and reports were planned for consideration and discussion by the members of this section of the Congress. Five only of these can be dealt with in this report.

In the paper read by Prof. Lunge, of Zurich, at the Thursday, June 4th, morning session, the author dealt with the "Present Position of the Sulphuric Acid Industry," and discussed the outlook for the various countries and manufacturers engaged in it. In the author's opinion, so long as the sulphur from 1,000,000 tons of pyrites is wasted in Spain by the open-air methods of roasting still in use in that country, the question of the scarcity of raw material for sulphuric acid manufacture cannot be considered to have risen to a position of importance. The improved methods of lead chamber construction and working were referred to, and the author expressed the opinion that, owing to the competition of new processes, manufacturers of sulphuric acid by the old lead-chamber process would require to make use of every improvement and invention of practical value in the economical working of the chamber process if they were to maintain their position.

As regards the "contact" or "synthetic" methods of manufacture, Dr. Lunge stated that these new methods were in use in an "astonishingly large" number of factories, and that not only fuming sulphuric acid, but also acid of lower strengths was being produced by this method of manufacture.

The paper closed with some statistical details of the industry, the figures for the production of sulphuric acid in recent years in the six leading countries being as follows:—

Great Britain	1,092,400 tons	... ...	1900
America	938,282 ,,	... ...	1900
Germany	878,000 ,,	... ...	1901
France	492,000 ,,	... ...	1899
Italy	about 200,000 ,,	... ...	—
Austria...	about 200,000 ,,	... ...	—

Another paper of statistical interest read at the Thursday afternoon session of Section II. was that by Mr. George Beilby, of Glasgow, on "The Present Position of the Cyanide Industry." The author opened his paper by referring to the collapse in December last of the arrangement between the leading European manufacturers of cyanide for regulating prices, and to the inauguration of a period of fierce competition between the producers. After giving some details of the newer processes patented for the production of cyanides, the author then gave the following figures for the present and prospective producing capacity of the potassium cyanide works in Europe:—

	Present.		Prospective.
Germany	2500 tons	... ...	4100 tons
France...	300 ,,	... ...	1800 ,,
Great Britain	4800 ,,	... ...	4800 ,,
Totals per annum	7600 ,,		10,700 ,,

Adding 5000 tons as the aggregate output of sodium cyanide by the countries named, he obtained a total of 15,700 tons as the prospective capacity of the European cyanide works, while the estimated consumption of cyanide made in Europe is not more than 5500 tons per annum. In view of this unfavourable position of the industry, from the producer's point of view, the price of cyanides for some time must necessarily be low, and in the author's opinion it will be unwise for manufacturers to attempt to raise it above 7½d. or 8d. per lb. In an appendix to his paper Mr. Beilby gave figures for the gold production by the cyanide process in all the leading gold-mining countries.

Papers upon "Methods of Cyanide Production," by Dr. F. Rössler, of Frankfort, and upon a "New Raw Material for Cyanide Manufacture," by Dr. G. Erlwein, Berlin, were then read, and the three papers were discussed together. The new raw material for cyanide manufacture is "calcium cyananide," a product obtained by heating calcium carbide in an atmosphere of nitrogen in an electric furnace.

Herr Vossen (Aachen), Mr. M. Muspratt (Liverpool), and Herr Rössler (Frankfort) took part in the discussion.

Section III.—This section was divided into two subsections—*a* and *b*. The first of these dealt with Mining and Metallurgy, and met under the presidency of Professor Weeren, of the Charlottenburg Technical School. A large number of papers of interest to engineers was presented to this section, but only those of Lürmann, Wedding and Fischer, and of Heyn, can be referred to in this report. The paper of F. Lürmann dealt with the presence of oxides of silicon, of manganese, and of aluminium in cast iron and steel, and with their deteriorating effects upon the quality of the metal, and urged the necessity for methods of analysis in the iron and steel industry which should permit the combined oxygen of these compounds to be separately determined. The method of analysis generally used for determining the combined oxygen in iron and steel, according to the author of this paper, does not give the combined oxygen of the impurities named above; and now that the use of ferro-silicon and aluminium is so general in the iron and steel industries, improved methods of analysis are urgently required. The paper by Wedding and Fischer, also read at the first meeting of the section on Wednesday, June 3rd, dealt with the absorption of hydrogen by metals, and especially by iron, and the influence of this hydrogen upon the physical properties of the metal. The authors gave the results of a large number of researches and experiments upon this subject in tabular form, and summed up their conclusions as follows:—

> In spite of the large number of investigations dealing with the "occlusion" of hydrogen by iron, the exact nature of the influence of this occluded hydrogen is still enshrouded in doubt. No accurate determinations of the temperature at which the greatest absorption of hydrogen occurs have been made, and methods for expelling the occluded hydrogen, or for rendering it harmless, are likewise non-existent. It is also desirable that investigations should be made to prove whether this occluded or absorbed hydrogen is the "cause" of the small cavities which occur in cast iron, as it is not improbable that the liberation of nitrogen or other gases may be the cause of these holes, and that the hydrogen found in them is mechanically carried there by the nitrogen or other gases.

The final paper which can be noticed in this report was upon "Metallography in the Service of the Metallurgist," and was read by Professor Heyn, of Charlottenburg, at the morning session of Section III.A on June 6th.

In a long paper, illustrated by numerous diagrams and photographs, the author emphasised the value of recent researches of a theoretical character on the borderland between physics and chemistry for the practical metallurgist. Commencing with a description of the phenomena observed with a solution of salt in water when crystallisation of the salt sets in, the author passed on to a consideration of the corresponding phenomena for the solidifying of metals and alloys, and in this portion of his paper dealt with the work of Stead, Gosselin, Osmond, Roberts-Austen, Rose, Charpy, and others.

In concluding a paper of considerable value, the author remarked that these researches of a physico-chemical character relating to the solidifying of metals and alloys were of the highest importance, both from the educational and practical standpoint; and that it should be the aim of all technical schools and their teachers to spread correct and up-to-date views on this subject.

Section III. (*b*) was devoted to "Explosives," and had as president Professor Will, of Berlin. At the Thursday morning sitting of this section Dr. Rasch, of Pankow, discussed the very important question of "Explosive Risks with Compressed Gas Cylinders." The laws regulating the manufacture and transport of compressed gases in all lands were, in the author's opinion, somewhat out of date, and needed revision in the light of later knowledge and experience. Two explosions of recent date in Germany—in 1900 and 1902—were especially dealt with, and Dr. Rasch gave expression to the view that in some cases the friction of particles of solid matter imprisoned in the exit valve of the cylinders had been the real cause of the explosion. The author finally proposed certain amended regulations for the manufacture and transport of liquid and compressed gases, and a commission of members of the section was appointed to consider and report upon these recommendations of Dr. Rasch, and also upon those of Dr. Lange, who discussed the question in a paper read at the same session of the section.

Another paper of some interest to readers of THE ENGINEER read before Section III.B at the session of Thursday, June 4th, was that by Dr. Fischer, of Berlin, and dealt with "The Accident Statistics of the Explosive Industries." The chief object of the author of this paper was to show that international accident statistics must be based on uniform principles and methods of collection if trustworthy comparisons were to be made, and the different points demanding attention in the preparation of such international statistics were individually dealt with. Dr. Denker, of Gummersbach, followed with a paper upon another branch of the same subject, and after some discussion the following resolution was voted upon, and carried by a majority of the members present:—"The International Congress thanks Drs. Fischer and Denker for calling attention to the need for international statistics relating to the manufacture and utilisation of explosives, and for the materials they have collected in aid of this object; and the Congress recommends that uniform principles and methods should be used in the collection of accident statistics in the various countries, and that where necessary, diplomatic means should be employed to attain this uniformity of system and method.

This resolution was accepted at the general meeting of

the members of the Congress on Monday, June 8th. Thirty-five papers were planned for reading before the two sub-divisions of Section III.

ENGINEERING CONFERENCE VISITS.

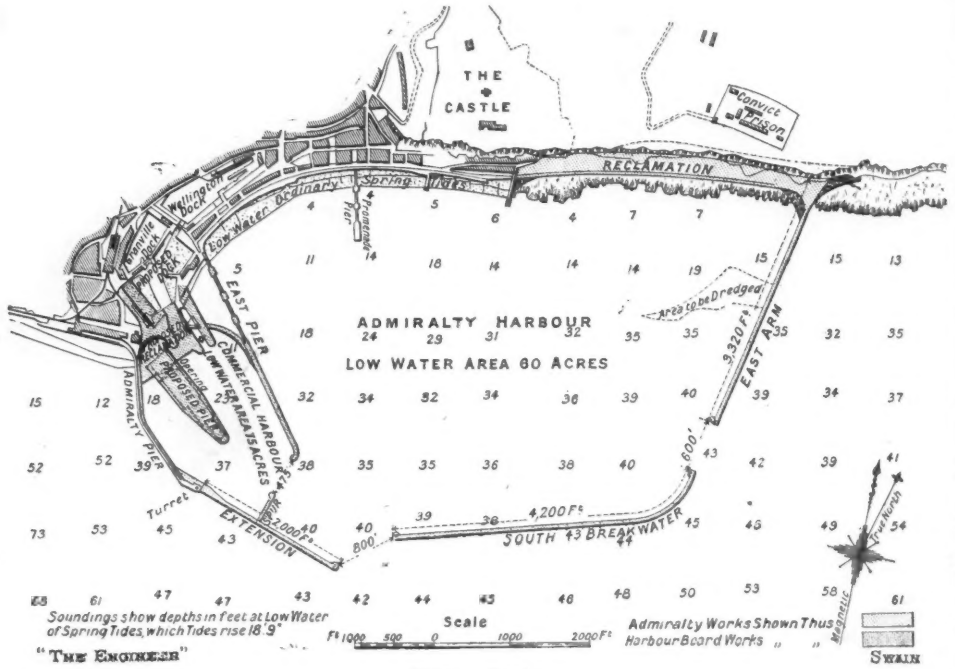
WE have given in our two last issues descriptions of several of the places of interest to which members attending the Conference of the Institution of Civil Engineers have been making excursions this week. To-day we give descriptions of the Dover Harbour works, and of the works of Messrs. Yarrow and Co., which have also been visited.

DOVER HARBOUR WORKS.

At Dover, which some of the engineers attending the conference visited yesterday, the Admiralty have, as most of our readers are aware, been for some time building a new harbour. It will doubtless be of interest briefly to trace the steps which have led up to the formation of this harbour, and to describe it generally. The accompanying map shows the shape and size the harbour will acquire when it is finally completed. It will be observed that the nucleus is found in the old Admiralty Pier, from which the majority of our readers must have embarked many times on their journeys to the Continent.

The history of the harbour is as follows:—We need not trouble ourselves about what took place in centuries gone by, for, practically speaking, they had nothing whatever to do with the present undertaking. In 1840, however, a Royal Commission was appointed to survey the harbours on the South-east Coast. This Commission recommended the plan of a harbour at Dover formed by a breakwater running practically parallel with the land, and at an average distance of 1000 yards from the shore, and by two arms projected from the land towards the eastern and western extremities of this breakwater. The estimated cost of the proposed works was £2,000,000. Almost immediately after this Commission had reported—namely, in the year 1844—another Commission was appointed to report as to whether it was desirable that a harbour of refuge should be constructed in the Channel, and what site would be most eligible having regard to accessibility, to its use if necessary for armed vessels, and to the facilities for defending itself which it possessed. This Commission concurred in pronouncing a favourable opinion on Dover as a harbour of refuge. They were, however, uncertain as to the suitability of the ground for anchorage purposes, and raised the question as to the possibility of the harbour silting. The first point was put at rest by the emphatic testimony, as to the excellence of the ground from an anchorage point of view, of Captain Washington in command of H.M.S. Blazer. As to silt, a further Commission appointed in 1845 to consider plans submitted by eight of the leading engineers of the day as to the form and construction of the harbour reported that "if liability to silt were deemed an objection, it would be idle to attempt such works on any part of our coast." This Commission practically confirmed the report of the 1844 Commission as to the form of the proposed harbour. As a result the contract for the Admiralty Pier was let in 1847. The structure was, save for a small addition to its seaward end, completed in 1871. Its total length is 2000ft. Nothing further was done towards completing the harbour, however, in spite of the fact that in 1881 a Committee appointed to report on the employment of convicts suggested the building of a prison on the East Cliff and the employment of convict labour to build a pier and breakwater at Dover "so as to form with the Admiralty Pier a large harbour similar to that at Portland."

The Admiralty Pier afforded very fair protection against a south-westerly gale, but with a south-easterly gale the pier was exposed on both faces, with the result that serious delay and inconvenience was felt while these winds were blowing. The Dover Harbour Board, therefore, since nothing was done by the Admiralty, decided to make a small harbour of their own. This decision was arrived at in 1890, and the work sanctioned by Act of Parliament in 1891. The work, which has been slightly modified by the later decision of the Admiralty to build the larger harbour, is shown in the plan, and is marked Commercial Harbour. The proposed pier, reclamation and lock, have not, however, been, as yet, constructed, nor, indeed, is the whole of the other work yet completed.



DOVER HARBOUR

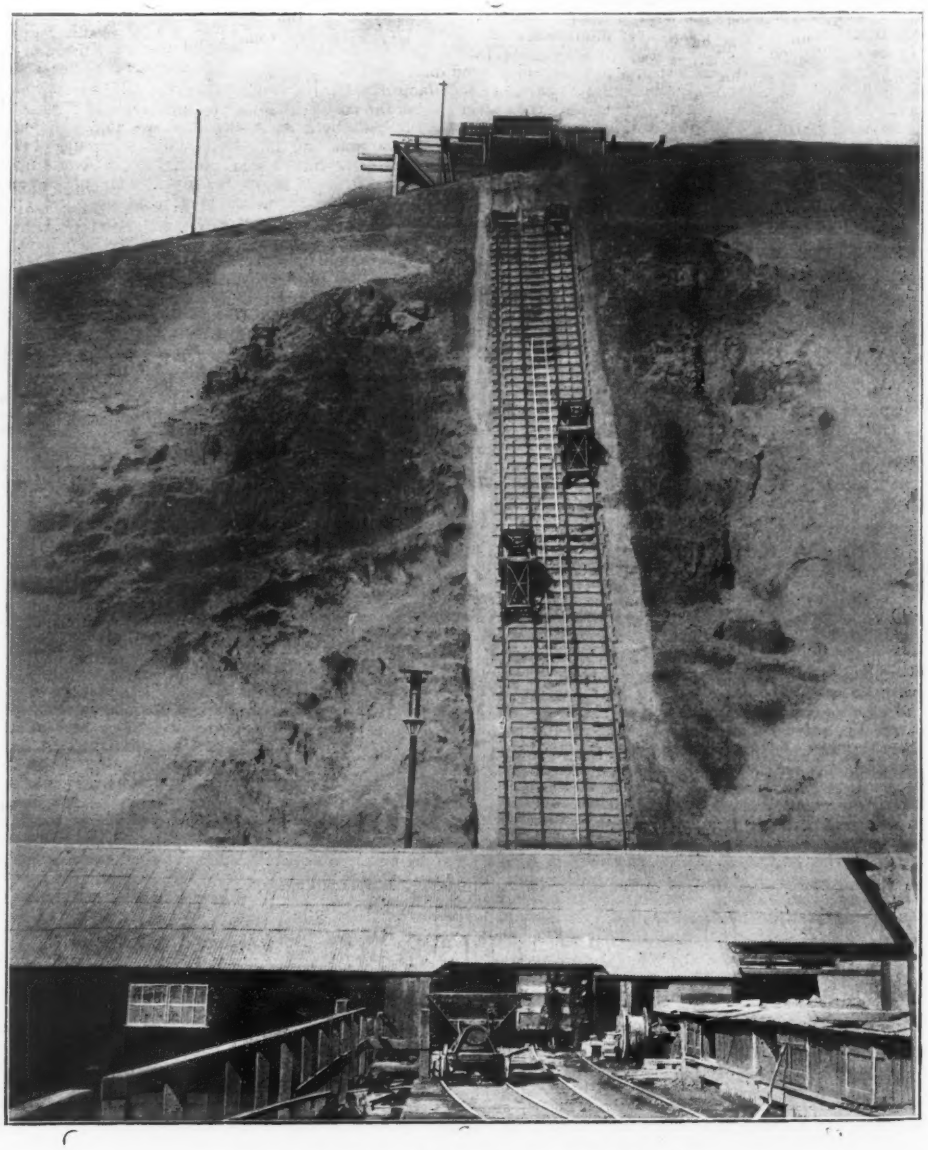
Towards the end of 1895 the Admiralty instructed Messrs. Coode, Son and Matthews to prepare plans for a large enclosed harbour. As a result the following recommendations were made:—(1) That the Admiralty Pier should be extended 2000ft. in an east-south-easterly direction, practically doubling its length. (2) That an east arm commencing a few hundred feet to the east of the eastern boundary wall of the convict prison should be run in a direction approximately south by west for a distance of 3320ft. (3) That an isolated breakwater 4200ft. in length should run generally west by south and east by north, but turning towards the north at its eastern end, and should form the southern protecting arm.

These recommendations are all shown on the map. The average depth at low water of ordinary spring tides on the line of this southern breakwater is 42ft. In addition it was recommended to reclaim 21 acres of the foreshore. The suggested arrangement of breakwaters left an entrance of 600ft. in width between the east arm and the south breakwater, and an entrance 800ft. wide between the extended head of the Admiralty Pier and the south breakwater. Both entrances have a depth of about seven fathoms at low water of spring tides, which rise 18ft. 9in.

These proposals were accepted, and the contract for the construction of the harbour was let in 1897 to Messrs. S. Pearson and Son. The total length of the sheltering works to be constructed is 9520ft., and the area enclosed, exclusive of the Commercial Harbour belonging to the Dover Harbour Board, will be 610 acres at low water, 322 acres being outside the five fathoms line, and 171 acres outside the six fathoms line. The project put forward by the 1840 Commission embraced a harbour containing a total of 450 acres, of which 320 acres would have been seaward of the two-fathom line. We may here mention that the area of the Commercial Harbour, which was originally to be 56 acres, will when the works are completed as altered be 75 acres. It will be seen that the end of the Admiralty Pier Extension is some 400ft. to 500ft. south of the western end of the south breakwater. This arrangement has been made with the object of helping vessels entering the harbour when the tide is setting eastwards at its greatest velocity. At such times the speed of the current is nearly four knots. It will also be useful during south-westerly gales.

In the present state of the works the Admiralty Pier extension and the east arm are nearing completion, and work is just about to be commenced on the southern breakwater.

The photographs which we are enabled to reproduce give an excellent idea of various portions of the works at different periods. The whole undertaking is of great interest. First of all a temporary yard was formed on the beach in front of the South-Eastern Railway Com-



INCLINED BALLAST RAILWAY DOWN THE EAST CLIFF

pany s town station. The blocks for the reclamation wall were built at Sandwich, where a large quantity of mixed sand and shingle was obtained. Originally these blocks were brought from Sandwich in lighters, but later on a light railway was built, by which they were delivered into the yard direct. Since the reclamation wall was finished the area enclosed by it has been utilised as a block-making yard for the east arm and south breakwater, the ground having been made up by material scarped from the cliffs. Ballast brought from Sandwich by the light railway is lowered down on to electrically-worked gantries running on rails parallel with the cliffs. Cement is also lifted on to these gantries, and the process of making the concrete for the blocks for the east arm is carried on by means of mixers as the gantries move towards the block moulds.

For the construction of the masonry breakwaters a grab worked from a powerful goliath crane removes all the loose material overlying the chalk. Another goliath manipulates an exceptionally large diving bell, by means of which the excavation and the levelling of the chalk bed are effected. This part of the work is very heavy, as no block is allowed to be set at a less depth than 3ft. below the surface of the solid chalk. The weight of the concrete blocks employed is 40 tons each. Above water level they are faced with granite. They vary in weight from 10 to 40 tons, the latter being the size most frequently used. Below low water they are set without mortar, but are well bonded and keyed together by joggles inserted into recesses cored out at the time the blocks are moulded. About low water the blocks are set in Portland cement mortar and are also keyed with joggles. The concrete mixing machinery, the character of the moulds used in the manufacture of the b'ocks, and the methods employed in lifting and setting them, proved of great interest to the visitors inspecting them; so also did the numerous cranes, gantries, and other machinery at work

It will be some while yet before the harbour is finally completed, but already the work is so far advanced that an inspection of it was well worthy of the journey it it entailed. There is no doubt that a magnificent harbour will be the final outcome of the present works. It will be sufficiently large to accommodate twenty first-class battleships, as well as numerous torpedo boat destroyers, gunboats, and other vessels of smaller type. It should also prove of immense utility as a harbour of refuge to merchant shipping in stress of weather.

Berths for coaling purposes are to be provided for a length of 1800ft. along the inner side of the east arm. For this purpose it will be necessary to dredge the area enclosed by dotted lines, for it is intended that all along the inside of the arm there shall be a minimum depth at low water of spring tides of 30ft. What is now the block yard will most probably be used as a coal store.

Dover will most certainly benefit by this splendid piece of engineering work, for it will become in the near future an important naval station. We may mention that the estimated cost of the whole work was about £3,500,000.

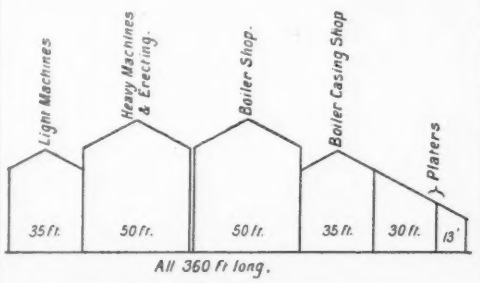
The works are being executed under the direction of Major Sir Henry Pilkington, K.C.B., R.E., the civil engineer-in-chief appointed under the Naval Works Loan; and of Messrs. Coode, Son and Matthews, the chief engineers by whom the design was prepared.

MESSRS. YARROW AND CO.'S WORKS, POPLAR.

These important works cover an area of about 11 acres, of which the main shop occupies one acre. In the yard the members had an opportunity of inspecting the building operations of ships of diverse kinds. The most important vessels are, of course, the four torpedo boat destroyers for the British Government, named the Ribble, Teviot, Usk, and the Welland. In the design of these several modifications have been made from the practice hitherto in vogue. The displacement is very much greater than in existing boats, and the speed will be lower—only about 25 knots. At the bows an addition in the form of a raised forecastle is built. This was decided upon only after the ships were well in hand, and necessitated much cutting away of the deck plates. The addition will provide much more space than is usual for the men, who will have airy quarters on deck. The forecastle will also contain a conning tower, fitted with a 12-pounder gun and a flying bridge above. Other ships to be seen in a forward state are two first-class torpedo boats and shallow-draught steamers, some constructed with the propellers situated in a tunnel on the principle which is well known to our readers.

The yard is equipped with the most approved labour-saving devices. A railway traverses it in all directions, and on this can be propelled a travelling jib crane, while the latest addition is a 40-ton electric crane by Ransomes and Rapier, which has been erected on the riverside for shipping heavy goods. This will probably be the means of obviating the putting on board of the machinery of vessels before they are launched, as at present practised. Most of the tools distributed about the yard are operated electrically by their own motors with the exception of the riveters, caulkers, chipping tools, and some drills, which are pneumatically worked. It may come as a surprise to some of the visitors to learn that the drilling of the rivet holes in the ship's plates costs less than punching, besides, of course, being better practice. The reason for this is that one plate acts as a jig for its fellow, and thus a large amount of time usually consumed in setting out the holes is saved. Much interest was evinced in some huge fork-shaped steel forgings which were seen lying about in the yard. These were the rudder frames, which are forged out of large slabs of steel, the spaces between the legs being cut away and the legs drawn out.

In our issue of April 5th, 1901, we described the fine shops which had then only recently been built. We are now enabled to give further views of the interior of these buildings, taken since they have been more completely equipped. The accompanying rough sketch gives an idea of their arrangement, together with their leading dimensions. The boiler shop is served by three over-head electric travelling cranes capable of lifting 10, 15, and 20 tons respectively. The shops are excellently lighted in the daytime by glass roofs, and artificial light is supplied by electric arcs and gas. It has been found that general lighting in large volumes is unsatisfactory where machine tools are concerned, and separate gas jets have been provided for each tool. The shop contains a 300-ton hydraulic press, by H. Berry and Co., of Leeds, for shaping boiler plates. On the top of the press—shown in the illustration on page 626—is placed a horizontal hydraulic ram, which serves to draw plates from the adjacent plate furnace by means of wire ropes on to the table of the press. The hydraulic pumps are steam-driven and are situated in a small house outside this building. They work up to 1500 lb. pressure per square inch, and this pressure is intensified by means of an accumulator. Near this tool is situated a hydraulic riveter for the ends of the water drums of the Yarrow boilers. In this machine the holding-up head is designed so that it can be swung back so as to give access through a somewhat limited size of hole. Next there was noticeable a large six-spindle electric motor-driven drill by Buckton. This is employed almost exclusively in drilling tube holes in the steam drums. Some rather interesting experiments were some time ago carried out on this machine with Speedicut steel drills, which showed a large economy both in time and power. The shop also contains, amongst other tools, an electrically-operated oval-hole cutting machine by Harvey, of Glasgow; a cold band saw for cutting off the ends of the steel drums; a machine for facing up plate ends after pressing by F. Berry and Sons, Sowerby Bridge; and a new design of radial drilling machine by W. Asquith, of Halifax, in which all the gear wheels are enclosed in an oil-tight casing, there being no belt and countershaft. Perhaps the most attractive tool in this shop is the large planing machine built by Bucktons, which has a bed 13ft. long. It is used for planing up the edges of the circular tube plates of the boilers, and has four heads with eight cutting tools, which can all be worked simultaneously. There is another heavy planing tool made by Hugh Smith and Co., Glasgow. This machine, shown on page 626, has a bed-plate about 30ft. long, and by its means a cut of 20ft. can be taken. The tool head is operated by a 30 horse-power electric motor and belt with screw-driving gear, and is put on the same class of work as that previously mentioned. All the tools in this shop which



GENERAL ARRANGEMENT OF SHOPS

have not their own self-contained motor are driven from a line shaft operated by a Siemens electric motor capable of generating 66 horse-power.

Entering the machine tool shops from the boiler shop, it was observed that a line of railway runs across one end of the whole of the shops. Overhead shafting is provided for all the tools. The shafting is driven by motors of various powers from 30 horse-power to 10 horse-power. In the erecting department an opportunity was given of inspecting the engines in course of erection for the destroyers previously mentioned. They are of the four-cylinder triple-expansion type, with piston valves throughout. The cylinder covers are of bronze, steel not having been found successful unless excessively thick. The propellers are also of bronze, and have three blades of unusually large area. This shop contains some admirable tools, and the tool stores are well equipped with their own machinery. In connection with this section of the shop, it is not compulsory for all the men to bring their tools in for sharpening. It has been found more economical, in cases where the men are some distance from the stores, to provide grinding machines in their own proximity. Power for the shops is supplied by three sets of Belliss high-speed compound engines, direct coupled to Parker dynamos, which also supply current for lighting. One set supplies 600 ampères, and the other two sets 430 ampères, at 210 volts. The sets are designed to couple up in parallel. The average load is about 800 ampères. Steam is supplied by three Lancashire boilers with Schmidt superheater; 100 deg. of superheat is the regular amount, and this has given a saving of 15 per cent. A new dry-back boiler by Frasers has also been installed recently.

The pattern makers' and joiners' shop is a separate building 220ft. long, and above this is a well-lighted "laying-off" shop. All the machinery in the wood-working department is driven by a 20 horse-power electric motor, placed in a pit below the flooring.

In the shops the premium system is universal, but in the yards the platers are on day work.

In a future issue we propose giving further engravings illustrative of these two visits.

PROBABLY the longest through run on an electric tramway system has, according to the *Street Railway Review*, been recently established between New York and Philadelphia. The time for the entire distance of 120 miles is approximately thirteen hours, with little waiting at connections and no walking. The cost in fares is about 1·30 dols., which works out in English coinage to about ½d. per car mile.

THE JAMES FORREST LECTURE.

THE James Forrest lecture possesses this year unusual interest, because, in the first place, it may be regarded as in a sense the first step in the proceedings of the Engineering Congress, and, in the second place, Mr. W. H. Maw, M. Inst. C.E., by whom it was delivered on Tuesday evening, has been especially happy in the selection of a subject which appeals to all engineers, and, to a considerable number of them, very specially indeed. The demands made on our space by a report of the proceedings of the Congress prevent us from doing much more than indicate the nature of Mr. Maw's lecture. It is noteworthy, we may say, that the Council of the Institution of Civil Engineers have decided that this, the eleventh lecture of the series, shall be the first of a somewhat novel type. Exception has been taken to preceding lectures by not a few persons, and notably by Mr. Forrest himself, on the ground that they did not deal, save remotely, with engineering. No exception of this kind can be taken to the present lecture.

After referring to the history of the lectures, Mr. Maw said:—

To avoid misapprehension, it may be well that I should at once say that I propose to employ the term "problems in engineering" in a somewhat restricted sense. We are in the habit of speaking of such matters as aërial navigation, the utilisation of the power of the tides, submarine warfare, and the distribution of energy, as "engineering problems"; and, no doubt, we are justified in so regarding them. But from the point of view I propose to adopt to-night, such subjects would appear rather as composite problems, each dependent for its successful accomplishment upon the solution of a number of more or less fundamental problems, one and all of which need separate and special consideration. Now, it is with some of these problems that I propose to deal.

The lecturer began naturally with heat engines, and set himself to show that we have by no means reached finality in the theory, the design, or the construction of heat engines of any kind. He advanced the very sound proposition that economy does not necessarily follow on the introduction of improvements, and that theory and practice apparently contradict each other not infrequently.

In his lecture on the "Development of the Experimental Study of Heat Engines," delivered by Professor Unwin in 1895, an excellent account was given of the origin and growth of the accepted theories as to the action of steam in an engine, and of the important effect of cylinder condensation on economical working. But Professor Unwin was careful to point out that whereas on theoretical considerations alone, the use of steam jackets might always be expected to afford highly beneficial results, yet in practice the economy obtained by steam jacketing varied greatly, and was in some cases a negligible quantity. The causes for this are, to a great extent, known in general terms. For instance, we know that the beneficial effect of jackets increases with an increase in the proportion of the area of the jacketed surface to the quantity of steam passing through the cylinder in a given unit of time, and also that it is apparently affected by the character of the jacketed surfaces. But when we come to quantitative results, we find that our knowledge is far from being of that exact and definite kind which is of real scientific value. And this state of things is reflected in the current practice of our leading steam engine builders. There are, of course, cases in which the question of jackets or no jackets is settled by considerations of cost or of weights, without regard to economy; but putting those cases aside, we find a divergence in practice which it is impossible to reconcile with the possession of adequate experimental data. Thus, we shall find, say, triple-expansion engines of practically the same size, and designed for the same steam pressures and piston speeds, and working under the same conditions, but constructed by different makers, provided with jackets to all cylinders and covers, with jackets to the barrels of cylinders only, with a jacket on the high-pressure cylinder only, or on the low-pressure cylinder only; with steam at full pressure admitted to all jackets, or with provision for varying the steam pressure in the different jackets; and for all these variations in practice the designers will, as a rule, be prepared to quote reasons which they regard as adequate. Now, the only satisfactory explanation of this condition of things would be that the differences in economy, consequent upon the adoption of the variations in practice to which I have referred, are so small as to be masked by the differences which necessarily occur in engine management; but, if this explanation were the true one, it would be an exceedingly strong argument for the entire abandonment of jackets in the class of engines under consideration, and for securing the consequent saving in the cost of construction which the omission of such jackets would effect. This explanation, however, is not a satisfactory one, and, in view of the great interests—monetary and otherwise—involved, it appears to me that the whole question of steam-jacketing, and particularly the application of such jackets to compound or multiple-expansion engines of modern types and of large power, using steam at high pressures, deserves a much more thorough and systematic investigation than it has hitherto received.

In the face of the investigations which have been carried out by an army of workers in this country and abroad, it appears to us, and will no doubt also appear to many other engineers, that further investigation along existing lines must be useless. Unless some entirely novel system of research can be discovered, nothing more will be learned, simply because there is no evidence that anything remains to be done except to settle the conditions under which the jacketing will and will not be economical, and these will vary with every engine. The lecturer himself obviously felt that a proposition for further investigations required some backing up, for he went on to say:—

It may appear strange that at the present stage of the history of the steam engine, and in view of the enormous number of experiments on such engines which have been carried out during the past half century, any such question as this should remain unsettled. But it must be remembered that not only are many of these so-called experiments wanting in scientific accuracy, but also that even those of the better class are often either incompletely recorded, or are—from the various characters of the engines on which they were made—very difficult to compare. There has also to be borne in mind the great increase in the size of engines and in steam pressures which has occurred during the past few years: increases which render earlier experiments inapplicable to present-day practice. And here it may be well to point out that there is a great difference between a strictly systematic investigation, such as I have in view, and an ordinary engine trial. Thus, to ascertain why, in a given instance, certain pressures of steam in the jackets of a compound engine have given the best results, we must have full information as to the condition of the steam in each cylinder of that engine throughout the stroke. We must know its pressure, temperature, and the amount of moisture it contains at admission, at the point of cut-off, and at exhaust; and we must be able to trace how far alterations in its condition are due to heat received from the jacket or to other causes. We must, in fact, if we desire to properly investigate

the merits and demerits of steam-jacketing under various conditions, not be content with ascertaining that in a particular set of instances the use or disuse of a jacket effected, or did not effect, economy; but we must trace out the reasons for such results, and be able to account satisfactorily for the disposal of all heat supplied to the engine.

Mr. Maw then proceeded to consider in some detail the multitudinous problems represented by superheating and interheating. Curiously enough, he passed over in silence the most interesting problem presented by the heating of feed-water with live steam, and he said nothing about ebullition, or the manufacture of steam. He did, however, we are glad to see, say:—

And, in connection with this matter, I may point out that we are much in want of a thorough determination of the physical properties of superheated steam, extending over the range of temperatures and pressures likely to be employed in practice. Such a determination may, I hope, soon be undertaken.

After a reference to Callendar and Nicolson's researches into the laws of the condensation of steam, and the experimental engines which abound in the technical colleges, he said:—

It is often said that internal combustion engines have reached their present state of efficiency almost entirely through the lessons afforded by the more or less crude trials and experiments of their makers and designers, and that they owe comparatively little to the researches of physicists. To a great extent this statement is undoubtedly true; but it is, I think, equally true that there has been reached a stage in the development of such engines at which a really systematic and exhaustive investigation of the conditions under which they work is calculated to afford most valuable aid.

He spoke next of the difficulties to be encountered in carrying out investigations, and paid a well-deserved compliment to Professors Burstall and Callendar. We do not gather, however, that the proposed research contemplates the possibility of introducing important practical improvements. It would appear as though further inquiry was intended rather to enable the physicists to ascertain why certain things happen than to enable the engineer to make better internal combustion engines.

Turning to statics, he went on to speak of the strength of structures, suggesting that investigation might take us a little further along the road to that ideal condition when "the so-called factor of safety, which might be more properly named the factor of ignorance," might be eliminated. Among other knowledge wanted is that of the action of the wind, particularly on the lee-side of roofs. If the conclusions drawn by Irminger as to upward pressure resulting on the lee-side of a roof from the action of the wind passing over it be fully corroborated, they must result in revolutionising our provisions for resisting wind pressures in many types of such structures. He pointed out that as many old girders are now being taken out of railway bridges, much information could be gained by testing them to destruction. After a reference to Wöhler and Bauschinger's investigations he used the following pregnant words:—

The great problem we have still to face—and it is a problem which will tax to the utmost our powers of research—is the determination of what the change which we call elastic fatigue really is. The indications of ordinary testing machines do not reveal any change in the behaviour of a material which has certainly exhausted a large proportion of its "life" under repeated applications of stress, and we must evidently, to solve the problem, have recourse to other modes of inquiry. What is the change of structure produced by fatigue, and in the case of any but pure metals is this change accompanied by any rearrangement of the constituents? How is this change of structure affected by variations of treatment, by annealing, or, in the case of steel, by tempering? Half a century ago we might have been inclined to answer these questions in an off-hand way, but we have now a better knowledge of the possibilities of change in the structure of a solid metal, particularly an alloy, and we have learned that an extension of that knowledge promises to open up the most certain road to securing for our use constructive materials possessing qualities far in advance of those now available.

After advocating the use of the microscope and touching on the decay of metals as treated recently by Milton and Larke, and a reference to the Engineering Standards Committee, he pointed out the nature of the assistance that the physicist can give to the engineer, and went on:—

I have said that the nickel-iron alloys, other than those particularly fitted for constructive purposes, present many special features of interest to the physicist, and I may mention here one series which also merits the attention of engineers. I refer to the most remarkable series of alloys discovered by Dr. Guilleaume, and which, under the name of "Invar," are now being largely used in France for the manufacture of standard gauges, pendulums, and similar purposes. The striking feature of these alloys—which contain about 35 per cent. to 36 per cent. of nickel—is their exceedingly small change of volume under variations of temperature, their linear expansion and contraction under the influence of heat being only about one-tenth that of platinum, and being thus practically insensible as far as ordinary atmospheric changes are concerned. It is to be noted that this result is obtained, not by the adoption of certain proportions of nickel and iron alone, but also by the special treatment to which the alloys are subjected, this treatment including long periods of annealing at very moderate temperatures. It is this latter point which possesses special interest for engineers. We have here the singular case of two metals, possessing about the same coefficients of expansions, giving, when mixed in certain proportions and subjected to certain treatment, an alloy possessing a coefficient of expansion which is only about one-thirteenth to one-fourteenth of that of either of the metals separately. Now, what are the structural conditions of the components of the alloy which admit of this result? So far as I am aware, the micro-structure of "Invar" has not yet been thoroughly investigated, nor has any information been published as to the changes which that structure undergoes during the special annealing processes which form an essential feature in the preparation of the material. Yet it seems to me that lessons of much practical value may be derived from such a research. In the construction of superheaters, some parts of water-tube boilers, and of certain details of internal-combustion engines, we are constantly experiencing annoyance due to the local expansion and contraction of the metals used, and if we could employ for such parts a material in which the expansion coefficient was greatly reduced, we should be relieved of much trouble. The discovery of "Invar" has shown that the existence of a metal possessing such a low coefficient is possible; and it remains to be ascertained whether by any special treatment an approximately similar condition can be secured in other alloys possessing structural value.

Speaking of rapid tool steel, Mr. Maw said:—

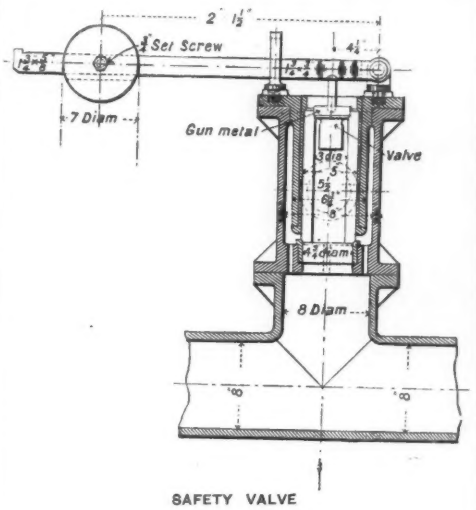
The new tool steels contain—in addition to iron and carbon—chromium, tungsten, and sometimes titanium and molybdenum, and Mr. Spüller's view is that in the point of the tool the excessive heating causes a portion of the carbon to leave the iron and form high carbides of chromium and tungsten. These higher carbides exist in the form of needle-like crystals of intense hardness, which are embedded in the soft iron carbide as in a matrix, and which form the real cutting portions of the tool. This view is supported by the fact that the points of these tools harden in use, and also by the form assumed by the tool points after heavy service; but it cannot be said to be absolutely proved, and the assumption that the formation of the crystals of chromium and tungsten carbides is due to the heating alone does not seem to satisfactorily explain the difference which apparently exists between the point and the immediately adjacent portions of one of these tools. There is, however, another action going on which may, I think, exert an important influence, and that is the extremely intense pressure to which the point of such a tool must necessarily be subjected. Of course, this is merely a suggestion, but I think it not improbable that further research may show that intense pressure and heat in combination can produce an effect which would not result from heating alone.

The address concluded with an apology, which was not needed, for saying nothing about electricity. He excused himself on the ground that it was not necessary that the importance of the problems presented should be urged in a James Forrest lecture.

It will be seen that Mr. Maw advanced many things to which exception may be taken, or about which opinions will differ, but no difference of opinion can exist as to the care with which the lecture had been prepared, the excellence of its diction, and the breadth of view manifested by its author.

SHREWSBURY WATER SUPPLY.

A PUMPING plant of novel description has recently been installed at Shrewsbury, in conjunction with the Corporation's waterworks, and the following short account of it will doubtless be of interest to many of our readers. Before going into details, however, it is necessary to say something of the conditions which have rendered this special plant necessary. For drinking water Shrewsbury depends upon a limited supply from numerous stand pipes in the streets; the general supply, which is brought into the houses, consists of unfiltered water drawn from the river Severn at the point where the river enters the town. The drinking water is pumped into a large water tower situated on high ground in the centre of the town, and the service is by gravitation from this tank. The tank itself is circular, of wrought iron, and stands on two concentric brick walls. The difference in height between



SAFETY VALVE

the bottom of the tank and the ground level at this point is about 45ft.

Owing to the building of several large residential properties upon the high ground at Kingsland on the opposite side of the river Severn, the demand for water has considerably increased in recent years. The well-known Shrewsbury Schools and numerous school houses are also on the high ground, and for these services the head given by the tank on the water tower proved insufficient. The demand in the Kingsland district is, of course, but a small fraction of the total water supply, and the plant we are about to describe has been installed for the purpose of giving the necessary additional head to this fraction.

The plant has been fixed in a portion of the space between the inner and outer walls supporting the water tower, and consists essentially of two motor driven-pumps and an accumulator with a ram loaded up to give a maximum head of 120ft., the whole arrangement being automatic in action. The pumps are of the three-throw single-acting plunger type with gun-metal double-beat suction and delivery valves, running at about forty-two revolutions per minute, driven through worm gearing by the electric motors. The pumps draw their water from the large tank, part of which forms the roof of the pump-room, and deliver it under the ram of the accumulator, the load on which gives the necessary increase of pressure. The ram is 26in. in diameter, and has a maximum travel of about 21ft. A crosshead is fitted to the top of the ram, running between guide rails fixed to a pair of massive timber guides. On the crosshead are fixed two projecting arms, one on either side of one of the guides, and a system of wires is fitted to this guide, and so arranged that at the bottom and top of the stroke the wires are pulled and the switches operated.

Under ordinary conditions, when the ram falls to a certain point, one of the pumps is started up, and if, as is usually the case, the water is being drawn off less rapidly than it can be supplied by one pump, the ram immediately begins to rise, and, on reaching the top of the stroke, switches the motor out of circuit. If, however, owing to exceptional demand for water or any failure of the first pump, the ram continues to descend, the second pump is automatically started up at a point about 2ft. below that at which the first one is started. The switches on the ram guide are of simple construction, operated by a lever and weight device to give a quick make and break. These switches close a subsidiary circuit through the solenoid of an automatic switch, which closes the main circuit on the starting switch. The starting switch itself is fitted with a solenoid and dash pot, which slowly pulls the arm over the contacts, whereby resistance is gradually out out of circuit as the motor comes up to speed. The current is taken from the municipal supply mains.

The whole of the switch gear is of the Sturtevant Company's standard pattern. The motors are of Messrs. Bruce, Peebles and Co.'s semi-enclosed type, rated to work up to 7 horse-power at 350 revolutions per minute, with a working pressure of 420 volts, but the power actually taken under normal conditions is under 6 horse-power, and we understand that the whole plant works smoothly and quite automatically, it being only necessary for the attendant to look in twice daily to see to the lubrication.

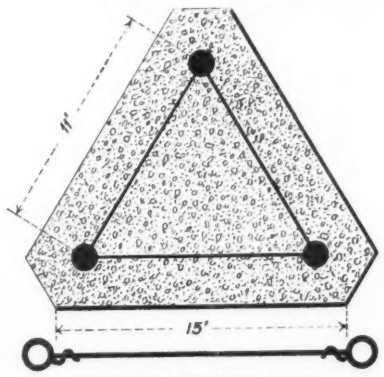
Between the pumps and the accumulator there is fixed an automatic relief valve of rather special design for preventing the quick descent of the ram should a burst occur on the main, and the pressure be suddenly lowered in consequence. This consists of an annular valve fitting the valve box cover, which is bushed with gun-metal and bored out with a seating formed at the top for the annular valve to close against. A similar seating is formed in the valve box for the lower end of the valve, and round this latter seating are four holes, half an inch in diameter, which, when the valve is closed on its lower seating, forms the only communication between the accumulator and the main. In the centre of the above-named valve is fixed an ordinary safety valve with weighted lever.

When the pump is started the pressure acts on the under side of the annular valve as well as the safety valve, and as the latter will only lift off its seat at a maximum pressure, the two valves rise together until the annular valve closes on its upper seating, and the water is then free to pass in or out of the accumulator as required; but should the pressure be lowered owing to a burst on the main or from any other cause, the annular valve, together with the weighted lever, would descend on to its lower seat, and close the communication between the accumulator and the main; but as there would still be a passage for the water from under the ram through the four half-inch holes, any sudden shock is prevented, and the ram steadily lowers until it comes to rest at the bottom of its maximum stroke on a rubber cushion.

This plant has been designed and supervised by Messrs. John Taylor, Sons, and Santo Crimp, of Westminster, who are also the consulting engineers for the comprehensive new main drainage scheme at Shrewsbury, which is now practically complete; and the contractors for the whole of the pumping plant were Messrs. S. Owens and Co., of 22, Tudor-street, E.C. We illustrate the plant on page 613.

FERRO-CONCRETE PILES.

FERRO, or armoured concrete, piles have received a very recent application in the erection of the new law courts at Berlin-Wedding. They are being largely employed in getting in the foundations, which are situated in poor and treacherous ground, with a very unstable coefficient of resistance. After many preliminary trials, it was determined to adopt the section shown in the annexed cut, namely, that of an equilateral triangle with bevelled corners. The piles are composed of clean, hard river ballast and Portland cement of the best quality, in the proportion of one part of the latter to three of the former. Their length varies from 17ft. to 26ft. The armature consists of three iron rods tied together at regular vertical distances by eye rods, spaced every 10in., having a diameter of a quarter of an inch, and set into the concrete with a blunt point at their lower end. According to the *Centralblatt der Bauverwaltung*, the concrete, slightly wetted, is carefully prepared in a pug mill, and deposited in vertical wooden moulds, in layers 8in. in thickness, subsequently reduced by pressure to about half that amount. Before fixing the tie rods and adding fresh doses of beton, the surface of



ARMOURED CONCRETE PILES

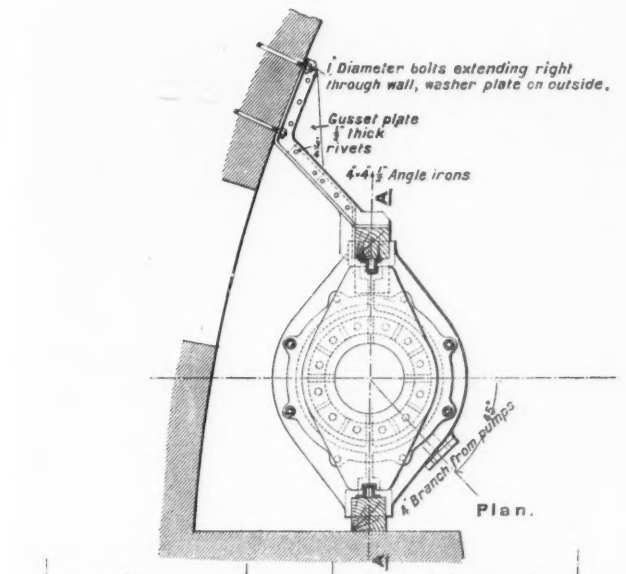
each preceding layer is roughened, so as to ensure a thorough mixture and incorporation of the whole mass. Thus manufactured, the pile is left to itself for a period varying from twelve to twenty-four hours. During the next seven or eight days it is watered constantly and abundantly. It is then taken out of the mould, and again watered for the next eight or ten days, and becomes sufficiently hardened and consolidated to be safely transported to the site of the works.

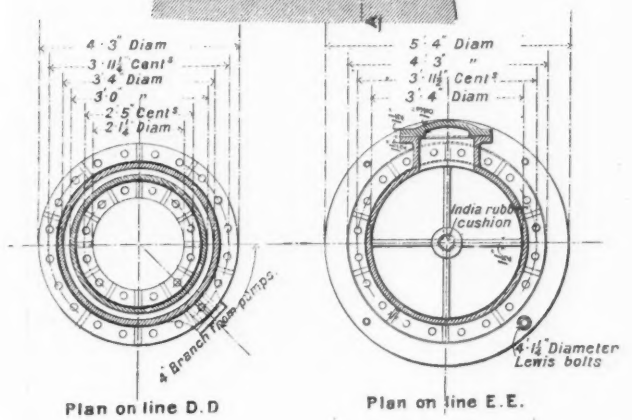
The piles are allowed to remain in this condition until they are about a month old, when they are fit to be driven, which operation is effected by means of a steam pile-driver, with a ram weighing two and a-half tons. To prevent the heads being damaged by the fall, which is 5ft. 6in., they are protected by a buffer, built up of sheets of lead, plates of iron, and timber packing, all held together by an iron ring. Special arrangements are made for guiding the piles in their descent.

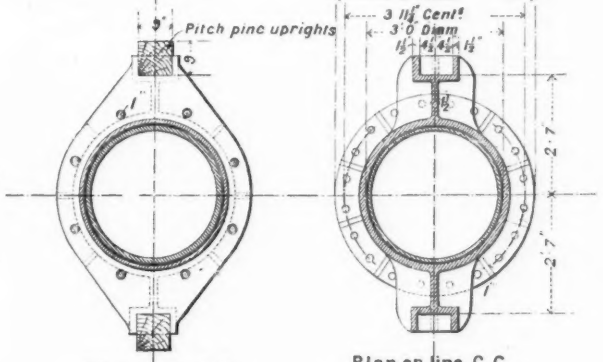
THE INSTITUTION OF CIVIL ENGINEERS.—The two conversaziones of the Institution of Civil Engineers was held in the Institution building on the evenings of Wednesday and Thursday last, the guests being received by the president, Mr. J. C. Hawkshaw, and Miss Hawkshaw. A number of models having engineering or scientific interest were on view, while in the lecture theatre there was an exhibition of views illustrating the recent volcanic eruptions in St. Vincent and Martinique. The evenings were enlivened by vocal and instrumental music.

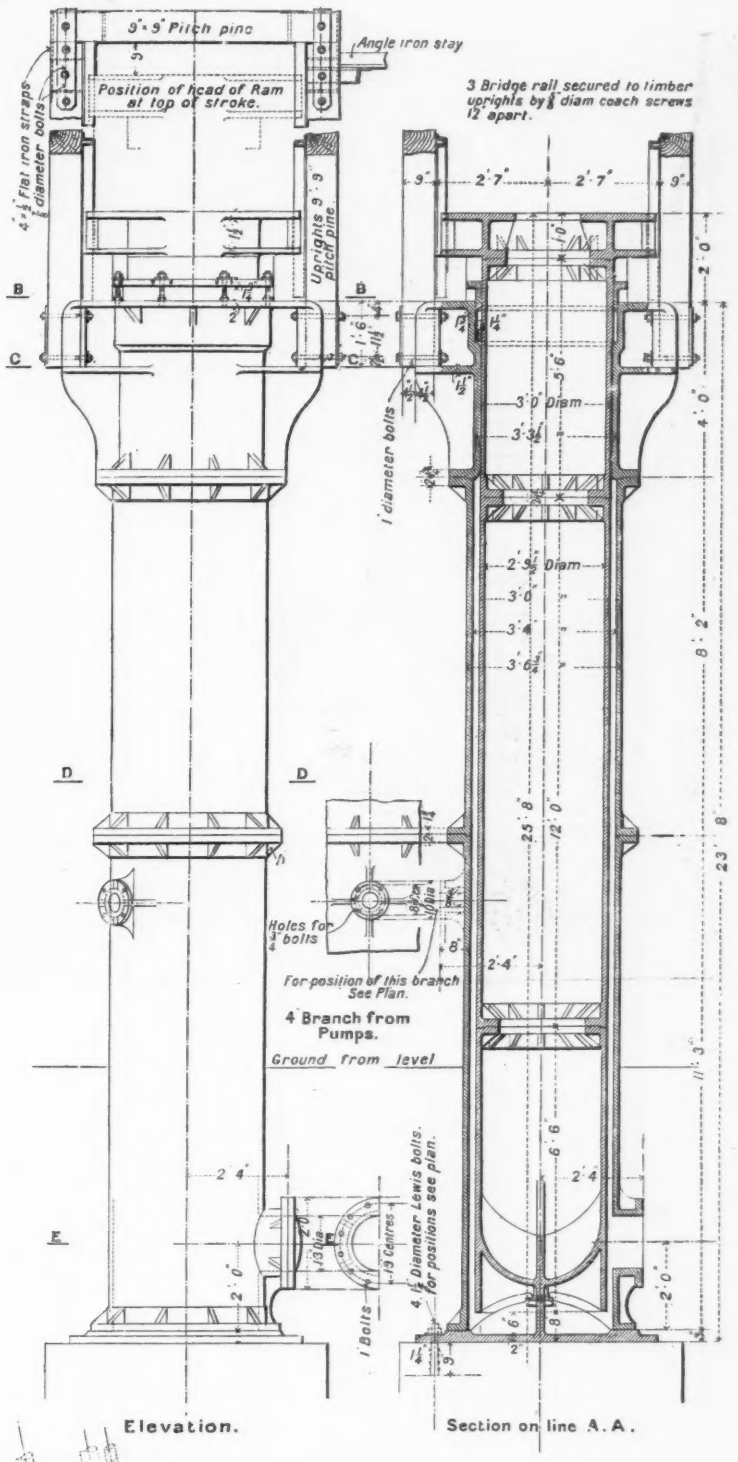
SHREWSBURY WATERWORKS—HIGH-PRESSURE PUMPING PLANT

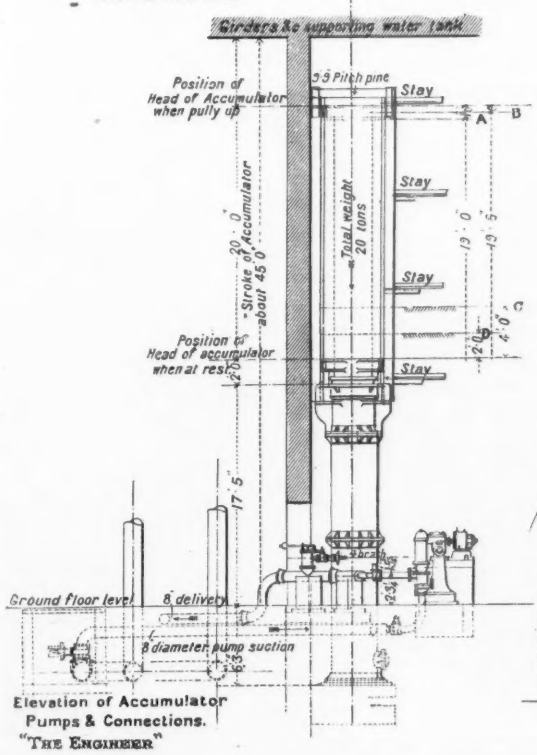
(For description see page 612)

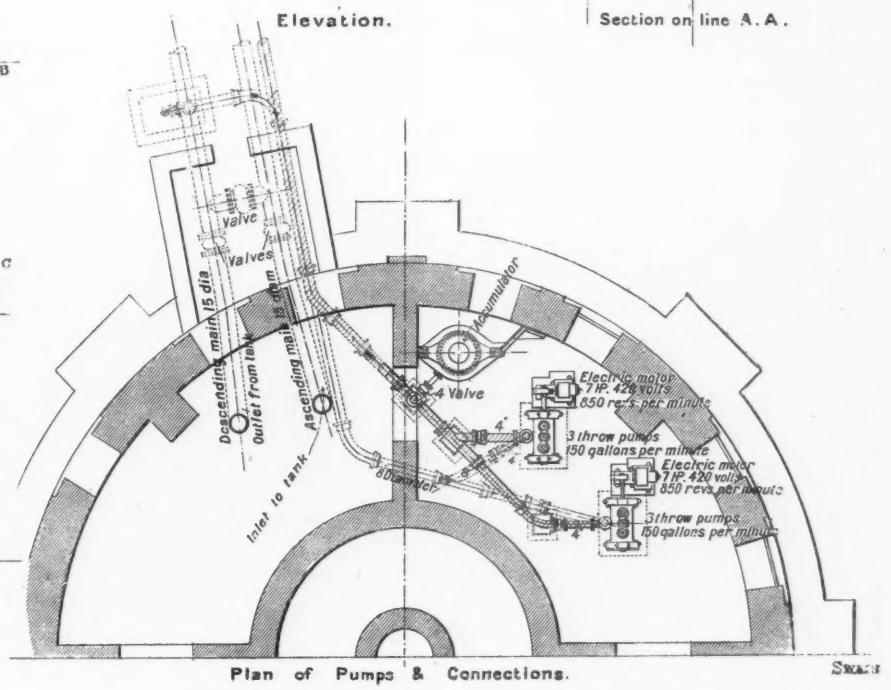






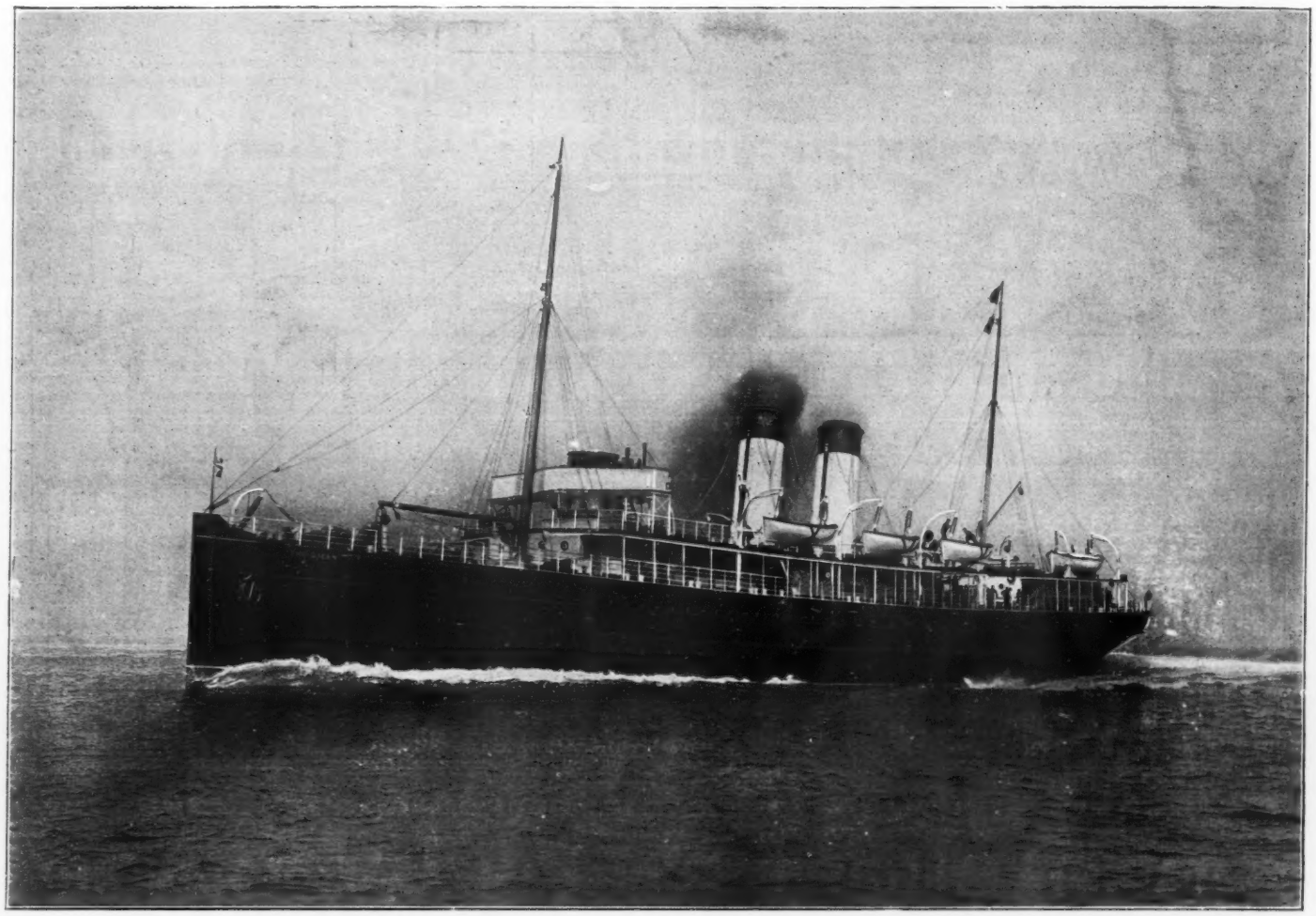

9"×9" Pitch pine
Angle iron stay
Position of head of Ram at top of stroke.
3 Bridge rail secured to timber uprights by ⅝" diam coach screws 12" apart.
4-4"×¾" Flat iron straps
1" diameter bolts
Uprights 9"×9" pitch pine
1" diameter bolts
3·0" Diam
2·9½" Diam
Holes for ¾" bolts
For position of this branch See Plan.
4 Branch from Pumps.
Ground from level
4-1¼" Diameter Lewis bolts. For positions see plan.
1" Bolts
Elevation.
Section on line A.A.




Valve
Valves
Descending main 15 dia
Outlet from tank
Ascending main 15" diam
Accumulator
4 Valve
Electric motor 7 HP. 420 volts 850 revs per minute
3 throw pumps 150 gallons per minute
Electric motor 7 HP. 420 volts 850 revs per minute
3 throw pumps 150 gallons per minute
8 Diameter
Inlet to tank
Plan of Pumps & Connections.

TURBINE CHANNEL STEAMER QUEEN

MESSRS. DENNY AND BROTHERS, DUMBARTON ENGINEERS



THE NEW TURBINE CHANNEL STEAMER QUEEN.

THIS new turbine steamer for the South-Eastern and Chatham Railway marks a departure in cross-Channel steamers, these vessels up till now having been either of the paddle or ordinary twin-screw type. The Queen, on the other hand, is an enlarged example of the turbine vessels which have been so successful for river purposes on the Clyde. She is 310ft. long, 40ft. moulded breadth, and 25ft. depth. She has a complete awning deck, and in large houses on this deck there are a number of special cabins provided. Amidships is the smoking room, framed in waxed oak, the seats being arranged in bays with small tables, and the floor laid with ornamental tiles. Above this first-class accommodation there is a promenade deck extending out to the ship's side, which shelters the awning deck in wet or rough weather, and provides a large promenade for passengers in fine weather.

The ladies' accommodation is in a large apartment on the main deck, framed in oak and enamelled pine. The settees of the apartment are arranged with spring seats to form berths for use on the night passage. Immediately below this is a gentlemen's sleeping saloon framed in panelled oak. Abaft this is the restaurant with seating accommodation for about fifty passengers. Twelve state-rooms and two special royal state-rooms are provided on the upper deck. The second-class accommodation is situated aft, the ladies' cabin being in large deckhouse on awning deck, the roof of which extends out to the ship's side, forming a sheltered promenade in wet weather. The gentlemen's accommodation is on the lower deck, and consists of comfortably upholstered sofa beds for the night service. The crew are accommodated on the lower deck right aft, and the officers and engineers on the main deck amidships. The appliances for working the vessel are exceptionally powerful, and consist of a large windlass and capstan, by Harfield, at the fore end of the vessel, and a warping capstan aft, by Paul and Co., Dumbarton. The rudder, which is large and of the single plate description, is worked by Messrs. Brown Brothers' steam tiller, controlled from the flying bridge by means of the makers' patent telemotor. For convenience in canting and backing out of harbour the vessel is fitted with a large bow rudder worked by steam steering gear of Bow, McLachlan's manufacture, controlled by a wheel on the flying bridge. As very heavy mails have frequently to be handled on this service, the vessel is provided with derricks and two large winches for dealing promptly with this matter. The vessel is heated throughout the passenger accommodation with steam, while there are also installations of electric light and electric bells, all this work being done by the builders themselves.

The sidelights, which are large and numerous, are of the "Denny-Porterfield" patent pattern. Special gear, designed by Captain Pett, of Dover, has been fitted for getting the boats out and in quickly, the idea being to carry the boats out at all times, only being swung in when coming alongside the berthing stage.

The main engines in the Queen consist of three separate turbines, each driving its own line of shafting, the centre turbine being high-pressure, and the two side ones being low-pressure. The central line of shafting carries one three-bladed propeller of about 3½ft. diameter, and each of the side lines h two propellers, three-bladed, fitted tandem, and well in advance of the centre propeller, but of only about 2ft. 3in. diameter. When going ahead in ordinary work, the steam is admitted to the high-pressure turbine, and after expansion there, passes to the low-pressure turbines, and then to the condensers, the total ratio of expansion being about 125 fold, as compared with eight to sixteen fold in triple-expansion reciprocating engines. At the ordinary steaming speed of the Queen, the revolutions of the centre shaft are about 700, and of the two side shafts about 500 per minute. This high rotative velocity implies the adoption of propellers of small diameter, and the utmost care is exercised in balancing them so as to obtain the full advantage of the absence of vibration obtained by the adoption of the turbine principle.

When going full speed ahead, all the lines of shafting, central as well as side, are in action, but when coming alongside a quay, or manœuvring in or out of harbour, the outer shafts only are used, thus giving the vessel all the turning and manœuvring efficiency of a twin-screw steamer. This manœuvring power is obtained thus:—Inside the exhaust end of each low-pressure turbine cylinder is placed an astern turbine, controlled by slide valves operated by combined steam and hydraulic reversing engines. These valves admit steam directly into the low-pressure turbines, or into the reversing turbines within same, for going ahead or astern. The centre turbine under these circumstances revolves idly in a vacuum, its steam admission valve being closed, and its connection with the low-pressure turbines being closed by non-return valves. The centrifugal circulating pumps and the air pumps—all of which are in duplicate, one set for each of the two condensers—are driven by independent double-cylinder steam engines, and the feed-water is supplied to the boilers by two of Weir's feed pumps controlled by a float tank into which the air pumps discharge the condensed water. There are also special pumps for wash deck and fire service, as also the various pumps for oil and water circulation, as required by Parsons' system. Steam is supplied to the turbines by two double and two single-ended boilers, Scotch cylindrical type, constructed by Denny and Company, the working pressure being 150 lb.

The funnels of the latest Dover and Calais steamers are fitted with the Denny and Brace spark arrester, by the use of which the decks can be kept very clean. The adoption of the Parsons turbine principle of propulsion for high speed vessels is being found not only to give a substantial increase in speed, but also, by the absence of reciprocating parts, complete freedom from the discomforts caused by vibration, and the jerk and throb of rods and cranks which are too apt to make themselves felt in vessels with the ordinary reciprocating engines.

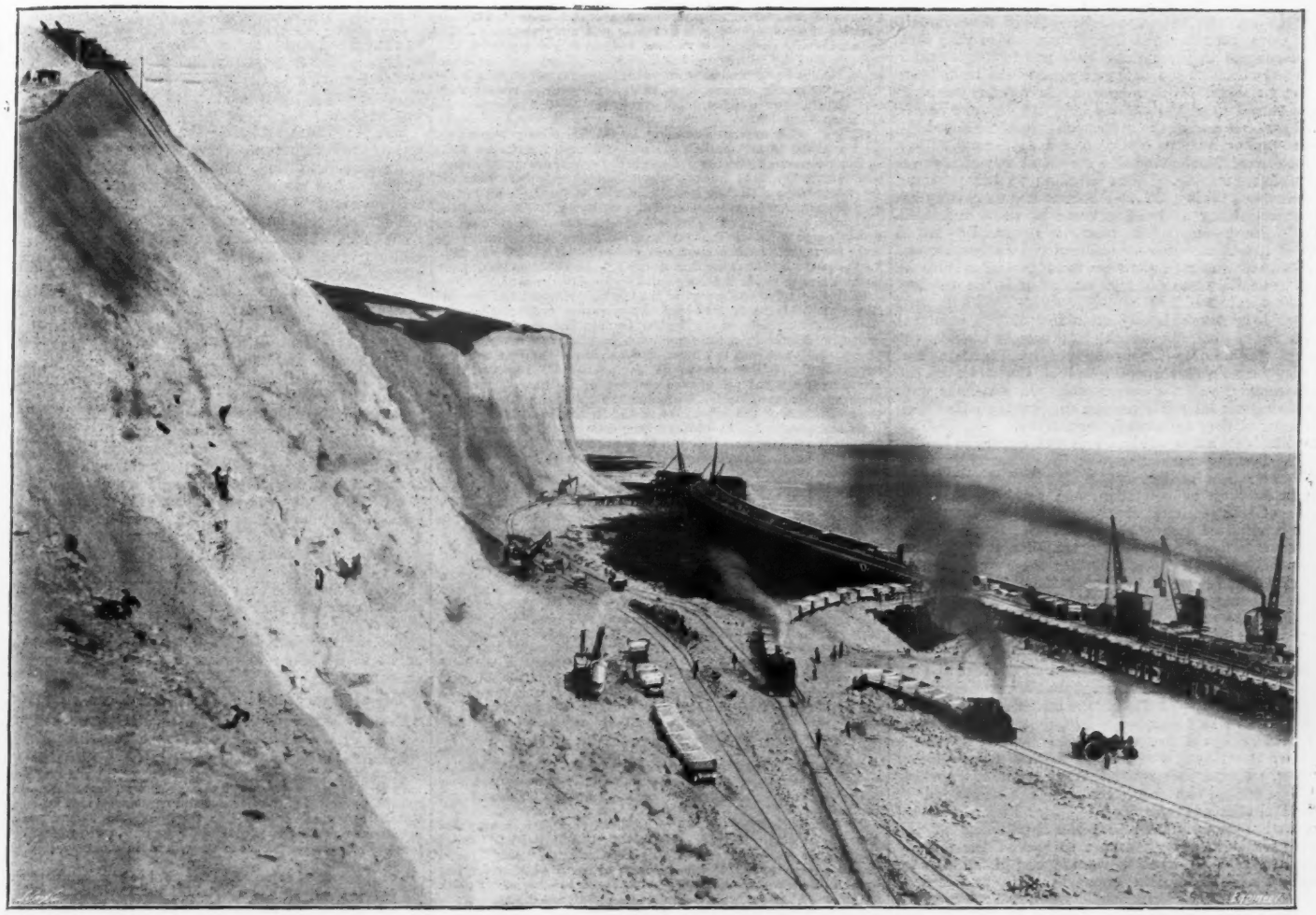
The Queen was tried for speed and manœuvring on the Forth of Clyde last week, the official trial resulting in a mean speed—from two runs over the measured mile at Skelmorlie—of 21·76 knots, one run, with the tide favourable, being equivalent to a speed of 22¼ knots. An interesting feature of the trials consisted of driving the vessel ahead at 20 knots and then reversing the turbines to full speed astern. This showed that she could be stopped dead in 1 min. 7 sec. in a length of 129 fathoms, or exactly two and a-half times her own length. On the occasion of the official trial, representatives from the builders' and engineers' firms, and from the owning companies, were on board, including Mr. Wallis Brock, Mr. John Ward, and Mr. Leslie Denny, of Denny and Brothers; the Hon. C. A. Parsons, the inventor of the marine turbine; Mr. H. B. Fisher, of the London, Brighton and South Coast Railway Company; and M. Delaitre, of the North of France Company. Builders and owners expressed themselves as highly satisfied with the results, and Mr. Wallis Brock, in proposing "Success to the Queen," said that the owning companies were to be congratulated on their courage and foresight in adopting this new type of Channel steamer. The steam turbine had certainly come to stay and to make a name for itself in marine engineering. Messrs. Denny and Brothers, it may be added, launched on Saturday last a further turbine Channel steamer—the Brighton—for the London, Brighton and South Coast and the Western of France Railway Companies' Newhaven and Dieppe service. This vessel is very similar in general appearance to her predecessor in this fleet—the Arundel—but, of course, embodies a number of improvements on that vessel which have been rendered possible by the adoption of the turbine system of propulsion.

ASSISTANT CIVIL ENGINEER, ADMIRALTY WORKS.—The Civil Service Commissioners have announced that an open competitive examination for four appointments as assistant civil engineer in the Department of the Director of Works of the Admiralty will be held in July next. Forms of application for admission to the examination, together with a copy of the regulations, may be obtained forthwith on request, addressed by letter, to the Secretary, Civil Service Commission, Burlington-gardens, London, W. The forms of application must be returned, so as to reach the Civil Service Commission, not later than July 2nd. It is understood that the salary commences at £200 a year, and, that assistant civil engineers are eligible for promotion to higher grades.

THE INSTITUTION OF CIVIL ENGINEERS.—The twenty-eighth annual dinner of the students of this Institution was held on Friday, June 12th, at the Trocadero Restaurant, when Mr. J. C. Hawkshaw, president, occupied the chair. There were also present amongst others:—Sir William White, K.C.B., Dr. Kennedy, Prof. Unwin, Mr. Tudsbery, the secretary of the Institute; but the dinner was not so well attended as in former years, probably on account of the proximity of the Conference this week. Mr. L. H. L. Huddart, Stud. Inst. C.E., and chairman of the students, proposed the comprehensive toast of "The Institution, the Secretaries of the Institution, and the Guests." He said that an incomplete conception existed with regard to the breadth of the Institution's work, which was not limited to civil engineering, but also embraced electrical, mechanical, and mining engineering, shipbuilding, and, in fact, every branch of applied science except military work. Speaking of the recent much discussed article respecting the object of acquiring engineering knowledge, namely, to make money, Mr. Huddart thought this was a calumny which is refuted by the lives of all the great engineers. Sir William White proposed the toast of "The Students." He said that last session there were 236 new additions to the student class, and that there are now more than 1000 students. He thought the best and kindest things ever done for the students was the introduction of the examination system, and humorously suggested that the standard of the examinations might be raised as time goes on. In conclusion, he hoped that the young members will uphold the prestige of British engineering, and advance the interests of the Institution of Civil Engineers. Mr. Hawkshaw spoke of the necessity of practical experience.

DOVER HARBOUR WORKS

(For description see page 610)



EAST YARD—RECLAMATION WORKS IN PROGRESS

GENERAL VIEW OF EAST YARD

THE INSTITUTION OF CIVIL ENGINEERS.

ENGINEERING CONFERENCE, 1903.

THE Conference of the Institution of Civil Engineers was opened on the 17th inst., the President, Mr. J. C. Hawkshaw, delivering a short address. This address, which we deal with below, was listened to by the members and visitors attending the Conference, before they took their departure to the various buildings in Westminster which have been placed at the disposal of the Institution for the occasion. We propose, as in former years, to give a summary of the various subjects brought before the Conference and of the discussions which followed.

The opening address was delivered in the hall of the Institution of Mechanical Engineers, at ten o'clock on Wednesday morning. After alluding to the previous Conferences held in 1897 and 1899 and commenting on the undesirability of holding them at short intervals, the President suggested that it might be found useful if the Conference committees should meet occasionally between the Conferences to suggest what subjects ought to be discussed and into whose hands the preparation of papers should be confided. The President then proceeded to touch briefly on a few of the principal events in engineering which had occurred since the Glasgow Conference—the opening of the Nile Dams and the Coolgardie water supply, and of the work of the Engineering Standards Committee. On all these subjects he had no later information to give than that with which our readers are already acquainted.

He then said a few words about the papers to be discussed, dwelling particularly on the opportunity that would be afforded for discussing the position of apprenticeship in engineering education, and touching upon the nature of the training demanded by the Institution before it admitted members. He referred also in favourable terms to Lord Selborne's scheme for the education of naval officers. Turning to other subjects of interest to engineers, he expressed disappointment that the report of the Committee appointed by the Board of Agriculture to inquire into and report on British Forestry did little to encourage planting in this country; and he alluded to two problems which at the present time concern London particularly, the prevalence of vitiated air and fogs and the difficulties of transport. Referring to the Royal Commission which had been appointed to inquire into the latter subject, he said that the terms of reference were very wide, and that it would tax the powers of even so able a body as the Royal Commission to find a satisfactory solution. The more facilities that are given for travelling and locomotion, the more persons are encouraged to travel and take advantage of the better means of transport and locomotion, so that the application of the remedy tends in some measure to spread the disease. Decentralisation is what is wanted, and if facilities for transport and locomotion encourage this, it will be a distinct gain to London, especially if it affects factories and workshops, the greatest offenders, with slow and obstructive traffic and smoke pollution.

As regards the best means of passenger transport, we have had, he said, experience of how the advent of railways checked the progress of canals and also of motors, which were far advanced nearly a century ago. It is to be hoped that tramways will not again check the progress of motors, and their use, not only for private, but for public service. Tram lines render roads less suitable or serviceable for all other kinds of traffic. It is well worth considering whether it would not be advisable to make roads suitable for motor traffic of all kinds, and let motors serve public as well as private purposes. Railways afford greater facilities than canals, but motors offer greater facilities than either railways or tramways, and though all three are necessary, nothing should be allowed to check the legitimate development of motor traffic.

To one who observes the changes which are taking place on many country roads, it is obvious that the question of their making and their maintenance will have to be considered, and that very soon. On Whit Monday one of our members told him he had the curiosity to count the number of machines passing on the Brighton road near Horley. In eleven minutes 209 motors and motor or other cycles passed, taking those going in one direction only. Probably few of the persons using them had contributed anything to the making or maintenance of the road.

He then concluded by dismissing the various sections to their meeting-rooms.

SECTION I.

The first paper read in the meeting-room of the Surveyors' Institution, Sir Guilford Molesworth in the chair, was that by Mr. J. C. Inglis on

"THE DESIGN OF PERMANENT WAY AND LOCOMOTIVES FOR HIGH SPEEDS."

The impact on permanent way arises necessarily from two sources:—(1) The condition of the permanent way itself; and (2) the design of the locomotive. The increase in the train mileage, at any rate on British railways, is mostly on long-distance traffic. This generally means heavy trains and heavy axle loads, hauled at a relatively high speed. The strength of the permanent way and the condition of the road bed are of the first importance, as when the permanent way is of a relatively light structure, or the road improperly packed and badly drained, there can be no satisfactory running at high speed. Indeed, with the increase in high-speed traffic there comes a more imperative necessity to give greater attention to these matters, as well as to the alignment of the lines and the super-elevation of the outer rail in curves than heretofore.

The next point is equally important, viz., the maintenance of a standard gauge width. The author has had instances of new road laid in straight line where the sleeper had not been adzed, and the chairing had been done by hand, and it was found that the gauge varied to the extent of $\frac{1}{8}$in. to $\frac{3}{16}$in. Although the permanent way was of a heavy section, the joints good, and the packing and ballasting properly done, the running was not satisfactory, so much so that the whole length so laid was re-gauged, and the traffic again sent over it at high speed, with the result that the engines and carriages ran comparatively quite smoothly.

Reduction of impact at switches and crossings and smooth running through junctions are largely brought about by attention to the following points:—(1) Making curves of easy radii. (2) Using long switches at diverging and converging points and avoiding short rails. (3) Working to a uniform gauge and giving special attention to levels. (4) Restricting the speed on curves. As crossings and junctions are very frequent in railways in Great Britain, attention to those points solves a considerable part of the question of smooth running. Swinging and swaying arise chiefly from suddenly changing curvature, and, as this depends on the laying out of the railway and the land at the disposal of the company, cannot be altered very much in the case of existing railways. Of course, in new lines there is no general reason why this disadvantage could not be met in the original laying out of the line.

On lines with expresses running up to 60 miles per hour no curves should be of less than 40 chains radius. I am aware that on many routes with high-speed traffic the curves are sharper than this, but all the same I think a speed of 60 miles per hour on curves of less than 40 chains radius should be avoided and is not good work. At least the length of a train, say 700ft., should be secured on the straight line between reverse curves where possible. I have enumerated shortly the main elements in the road which make for reduction of impact, and consequently smooth running, for the purpose of showing that it is recognised that no small part of the question lies in the design and up-keep of the road.

In appendix 4 of the report of the Committee appointed by the Board of Trade to inquire into the vibration produced by the working of the traffic on the Central London Railway, on page 10 occurs the following, as the result of a mathematical investigation of the wheels and rails in respect of the action of the road and the irregularities of the surface in contact:—"If, however, the unstrained rail has an uneven surface, or if there is want of uniformity in its supports, the stiffer the rail the smaller will be the amplitudes of the vibrations in the ground and the greater their frequencies." In ordinary language, at high speeds the heavier the rail the smoother will be the running with a given up-keep, a principle which is working out, at any rate, in this country with the chair-road, at a weight of rail of 90 lb. to 100 lb. per yard.

But beyond the question of the permanent way is that of the design of the locomotive to run upon it, which cannot be quite separated from the former question. All who are connected with railways know only too well that some types of locomotives, when driven at high speed, oscillate laterally and vertically to a dangerous extent even on a good road, and that the only way to obviate this is to reduce the speed. Locomotives having four wheels coupled in front and a bogie under the footplate—4-4 American notation—are a specially undesirable class to be run at high speed. In proof of this may be cited the Doublebois accident on the Cornwall Railway on May 13th, 1895, in which two such locomotives of a fast passenger train left a practically new bull-headed road having easy curves, due to the type of locomotive in use. Engines with single drivers and only one axle in front with one behind are likewise unsatisfactory and plunge considerably at high speeds even on good roads, and there can be no doubt that the introduction of the leading bogie, giving a longer wheel base, is the greatest improvement in this respect which has yet been carried out, and, with the increasing weight on the driving wheels, is, in my opinion, necessary to secure steadier running and easy passage on curves; drivers have much greater confidence in such engines.

Of late, owing to the increased loads and the consequent desire to obtain greater adhesion and tractive force by additional coupling or weighting of the coupled wheels, the "pony" radial axle has come in, but it yet remains to be found whether for fast running the pony axle has the advantages of the bogie. I think not, and the bogie wheels are undoubtedly safer at diamond crossings in curved lines. Personally, I think the equalisation of weights by the bogie over four points is by far the best, and reduces impact, and is so important that, even to save a few feet in length of engine framing, should not be given up. The introduction of levers to equalise the weight on the single leading axle with that on the front driver has much to recommend it, although, in my opinion, it cannot so satisfactorily equate the varying weights as the ordinary four-wheel bogie. This latitude given to the driving wheel is not theoretically desirable, the object of all steadying arrangements being to ensure that the front end of the engine shall creep and not jump, and so to prepare the way for the driving axles to operate at their full efficiency. The steadier the driving-wheels are kept the greater will be the efficiency and the less, consequently, will be the wear and tear of the road. This principle ought to underlie all locomotive building, and for this reason, I think, the provision for steadying a locomotive should be separate entirely from that for driving.

For the same reason the more the driving-wheels are equalised as between themselves the greater will be the adhesion and tractive force. The extent to which this is carried in America is shown in Mr. Cowan's paper on "American Locomotive Practice," read at the Institution last session. What maintenance engineers on railways want are creeping machines and not hopping machines, and these will cost locomotive engineers less to maintain. One advantage of the four-wheel coupled engine over the single, at high speed, is the fact that the counter-balancing can be spread over four wheels in place of two. No doubt this is the principal reason that it is so difficult to build a single driving-axle locomotive, even with a bogie in front, to run smoothly. Several companies in Britain have tried compound locomotives with three and four cylinders, and the Great Western are awaiting delivery of a French compound, having four coupled wheels with leading bogie and trailing axle, from the makers of those used by the Northern of France Company. I have great hopes that the running of this engine with its four cylinders, long wheel base, and the weight concentrated more towards the middle, will effect a further equalisation of the counter-balancing, and so conduce to smooth running.

It may be remarked that the running behind compound engines in other countries is not free from oscillation, but from many inspections I am inclined to attribute this to shortcomings in the road and not to the build of the engine. Recent practice has been in the direction of raising the centre of gravity of the locomotive, but, although locomotives with a high centre of gravity are, theoretically, first-class machines if running on a perfect road, I would suggest that this practice has its limit, and that that limit is now reached with our present conditions, for the reason that any imperfection in the alignment of the road has a correspondingly increased effect in developing swaying or side motion in the engine at high speed, which, when developed, is more intense and more lasting than with lower-built locomotives. It may be gathered from the foregoing that a practical disadvantage is found to arise from such engines having to run through yards and junctions, where the full cant necessary for the speed at which the train is running cannot be obtained.

Sir Guilford Molesworth explained that owing to the death of Sir J. L. Wilkinson, Mr. Inglis could not attend.

The discussion was opened by Mr. Jacomb Hood, who said that they were agreed as to the essentials of a good road. The maintenance of the track in perfect gauge was a matter of vital importance. The consideration of details would give an opening for discussion. It was a remarkable fact that no uniformity of practice existed among engineers as to the way in which chairs should be secured to sleepers. He then described the Great Western system, as carried out at Southall. Stepped seats are cut for the chairs by a machine, the stepped foot of the chair fits these. The sleeper is bored in a machine, then the chair is pressed into place with a force of 10 tons. Two bolts are passed up from below, and two nuts are screwed down, all by machinery, and so absolute contact is got between the chair and the sleeper. He liked the four-wheeled leading bogie, and thought that engines with leading wheel drivers, like those on the Brighton line, are very bad for the permanent way.

Mr. Lionel Wells held that forty-chain radius used to be considered ample for any curve. The whole question was one of super-elevation, and that was left too much to the discretion of the district engineer. A distance of 700ft. of straight between curves was much more than was wanted.

Mr. Macintosh said that the standard American rail was at the very bottom of the list of thirty sections, and the reason was that, being designed for a soft wood sleeper, it had too much metal in the foot. The Argentine standard came out best, because it was for hard wood sleepers. He then gave various figures going to show that the heavier the rail the greater was the economy, in so far as wear, tear, renewals, and interest on cost were concerned.

Mr. Lart asked how it was that if close contact was necessary between sleeper and chair, the London and North-Western road, with a sheet of felt between the two, was probably the best road in the world? He did not at all agree with Mr. Inglis about locomotives. The six-wheeled 7ft. 6in. single-driver Ramsbottom engines did not plunge or roll. The unsteady engine was that with a bogie, which was always on the hunt. At Penrith is a curve of forty chains radius, and round that with engines without a bogie he had been over and over again at 70 miles an hour with perfect comfort. The outer elevation was 5in. He concluded by quoting the late Mr. Stirling's views about bogies. He was followed by a speaker who urged that curves should be arranged with a view to the comfort of the passenger as well as his safety. Sixty chains should be the least for 60 miles an hour.

Mr. Johnson said that Mr. Lionel Wells was mistaken if he supposed that super-elevation was left to the district engineer. Even the gangers were supplied with tables, and were made to work to them. Great care ought to be taken to preserve the gauge accurate at crossings.

The next paper read was by Mr. A. Ross, on

"THE ASSIMILATION OF RAILWAY PRACTICE AS REGARDS LOADS ON BRIDGES UP TO 200FT. SPAN."

Questions of standardisation have for some time past been freely discussed by Institutions and the public and private Press, and it may be taken to be admitted that engineers, manufacturers, and consumers meeting in conference and agreeing to standard sizes of materials required for specific purposes, and to uniformity of practices as regards specifications, tests and quality of materials, must result in increased efficiency, and in economy of cost and time.

The Institution has recently done good service in taking such an active part in the work of standardising materials, and in having, amongst other matters, dealt with the various sections of steel used in the construction of bridges.

While it is undesirable to carry standardisation to such an extent as might tend to arrest advancement in type or design, it is of the utmost importance that uniformity should be arrived at with regard to the loads to which such structures may be subjected, and the intention of this communication is to indicate the anomalies and difficulties that exist, with the view of inviting discussion on the points raised.

Bridges for railways may be divided into two classes:—

(1) Those carrying railways over highways, waterways, rivers, &c., the loads being guided in their course by a track fixed in position.

(2) Those carrying highways, &c., over railways, with or without a fixed track to guide the loads.

With the first-named class the general practice has been for the engineer to select the heaviest type of engine in use on the line as a basis for the maximum load for small spans, and to assume a combination of the engines giving the greatest stress for larger spans.

To meet the requirements of traffic, locomotives of increased size, strength, and weight have constantly been designed with little or no reference to the strength of the bridges which have to carry them, with the result that bridges which ought to have lasted for a considerable length of time became early overloaded and overstrained, and had to be either strengthened or replaced.

Within recent times a decided increase has been made in the weight of locomotives, and also in that of passenger vehicles and goods wagons, and it is difficult to say whether we have yet attained the maximum, but the fact of the load gauge being practically taken up to its full capacity points to the margin left being small.

Road Vehicles.

Vehicles.	Length over all.	Width over all.	Length of wheel base.	Weight on rectangle enclosing vehicle, lb. per square foot.	Weight on rectangle enclosing wheel base, lb. per square foot.	Number of axles.	Maximum weight per wheel.	Total weight loaded.
	ft. in.	ft. in	ft. in				Tons	Tons.
Tramcar, double-deck, single truck	27 5	7 0	6 0	127	893	2	3	11½
Tramcar, double-deck, bogie	33 6	7 1	13 6	139	497	4	2¾	14¼
Tramcar, double-deck, bogie	35 0	7 0	16 0	159	496	4	2¼	17½
Tramcar, single-deck, bogie	35 0	7 0	17 0	138	380	4	3	15
Tramcar, vestibule combination, single truck	30 10	6 9	6 0	103	728	2	2½	9½
20-ton road roller	20 3	8 3	11 7½	268	482	2	6¾	20
15-ton ,,	19 7	7 3	11 6	235	403	2	5	15
Traction engine	—	7 2	10 2	—	585	2	7	19
,, ,,		9 7	15 0	—	342	2	8	22
,, ,,	18 4	7 10	10 7	176	305	2	—	11
Boiler wagon	—	—	13 0	—	1170	2	12	48
,, ,,	—	—	22 0	—	—	2	9½	38
Stone ,,	—	6 8	9 0	—	600	2	4	16
Steam lorry	—	—	11 6	—	392	2	4½	10½

Each of the large railway companies has distinctive types of locomotives, and as there is an extensive interchange of traffic between the companies, it appears desirable that all railway bridges in this country should be strong enough to take the heaviest engines or combination of engines in use on any railway.

Tables accompany the paper giving the equivalent uniformly

distributed live loads derived from the maximum bending moment caused by engines running on different British railways, and the examples taken are believed to be representative of the heaviest engines of the classes named used throughout the country.

Consideration should also be given to the increased and continuous weights given by a train made up of large wagons of forty tons capacity or of wagons loaded with boilers, girders, or other heavy materials, in many cases approximating to that of a train of engines.

Highway bridges.—Dealing with bridges carrying public highways, accommodation roads, &c., over railways, a table has been compiled from information collected recently, from which it will be seen that highway bridges are subjected to very heavy weights, and not unfrequently heavier weights than those shown on the table pass along the streets of towns drawn by two and sometimes even three traction engines.

The discussion which followed ranged over a good deal of ground, and would no doubt have proved valuable had more time been at the disposal of the speakers. Much turned on the standardisation question. Mr. Upcott said that, representing the Indian Government, who owned the major portion of the 25,000 miles of railway in India, the question of standardising bridges had long occupied his attention, and finally they had succeeded in devising standard bridges up to 350ft. span. A great difficulty which they had to contend with was that there are two gauges in India—viz., 5ft. 6in. and the metre gauge. For some years they had used a type engine to determine weights, but this had been given up, because the type engine was quite impossible, and a series of revised rules had been prepared for the guidance of all concerned. Mr. Upcott then asked Mr. Robinson to explain these rules. Mr. Robinson laid copies of the rules on the table, and explained that they dealt with shearing and moments separately. An average curve was drawn through the scales, and accompanied the tables. The allowance for wind pressure was 56 lb. per foot for the bridge unloaded, and 30 lb. per foot for loaded bridges. Eight tons were allowed as maximum tensile stress on the net area, five tons for shear, and eleven tons for pins and rivets.

Mr. Mason said that engineers might standardise as they liked, but they worked in a circle, and always in the end came round to the Board of Trade. He held that this standardising system was being overdone. It would end in curbing imagination and hampering the genius of the engineer. Besides, it was not to be expected that the rollers of standard sections would keep great quantities in stock, and in the end the builder would have to wait just as long for his material as if it had to be rolled specially for him. After all, weights and bridges to carry them were developed in obedience to the operation of some natural law—we presume the speaker meant the survival of the fittest. To him it appeared that 10 tons on a wheel represented a maximum which could not be exceeded. He urged on those engineers who had old structures to take down to examine them carefully, as no doubt most useful lessons could be drawn from them. It would be we well to remember that serious mistakes might be made in bridge designs by trusting to parabolas and moments. One bridge came under his notice in which shear had been neglected, with the result that the rivets were exposed to a shearing stress of 18 tons per square inch. As to cross girders, he did not agree with Mr. Ross. He held that maximum economy was attained when the weight of the cross girders and rail girders was the same.

Mr. Cudworth said that they need not fear over standardisation. Standards must be the servants, not the masters of engineers. Leaving railways, he went on to consider road bridges, and held that the maximum load to provide for in this country, two 15-ton road rollers passing at the same time, represented a fair standard. In large industrial towns the loads would be heavier, as when boilers were being moved. He did not think that for railways it was necessary to study the ten-wheeled coupled engine. It was and must be exceptional. The eight-coupled and six-coupled made good standards of maximum loads.

M. E. Sauvage, of the Western Railway of France, said that M. Habut had invented a most ingenious apparatus for testing deflection, and thanks to its use they had been able to demonstrate the absolute safety of certain old bridges which must otherwise have been condemned.

Mr. Barton held that we were going too fast, and putting up bridges to carry weights which would never run on them, because the electric motor would supersede steam.

Mr. Moncrieff said that he was glad to see the whole subject opened up; he had brought it forward in 1897. The design and proportion of bridges was in a chaotic condition, and he urged that engineers as a body should take steps to reduce it to order. He held that it was quite a mistake to say that axle load settled the design. It was only one factor. He did not agree with Mr. Mason that rail and cross girders should be the same weight; too many cross girders only augmented cost, and introduced a multitude of useless joints and rivets. In the United States they adopted large panels, and that was good practice.

Sir Guilford Molesworth said that years ago he had tried to introduce standards, with the result that he had satisfied no one. It was beyond doubt that the older railway bridges were all over loaded. If there were standards for the main girders, there must be standards for the cross girders as well.

In his reply, Mr. Ross said that it was good policy after all to provide for the heaviest load that could be got on the available dimensions of loading gauge, and he hoped that a good many steam locomotives would yet be built.

A paper was then read by Mr. W. J. Cudworth, on

"AUTOMATIC SIGNALLING."

Automatic signalling, *i.e.*, signalling by means of which railway trains themselves actuate the signals, protecting them without the attendance of signalmen, has been the dream of the inventor since the introduction of railway signalling. Countless plans have been proposed. Most of them, however, depend for their action upon a contact between something depending from the train and apparatus fixed upon the permanent way, which contact does either mechanical or electrical work. Many of these proposals have been made without sufficient knowledge of the relation between the load and structure gauges, and of the difficulties inherent in exceeding either or both of these, as is necessary in every contact apparatus, as well as of the difficulties arising from contact at the speeds of express trains.

Allusion must, however, be made to the successful working of contact apparatus in special cases, such as the Liverpool Overhead Railway—described by Mr. Cottrell, M. Inst. C.E., in vol. cxliv. of the "Proceedings" of the Institution. Mention must also be made of the various treadle systems auxiliary to the ordinary block system, which, although they do not supersede the human agent, as is the aim of the automatic system, do, at any rate, provide an automatic check upon his fallibility. With the development of the railway system in the United States, expensive labour and great lengths of line made the question a more urgent one than in this country; and between twenty and twenty-five years ago experiments were conducted, and some automatic signalling installations made, which depended for their action on the short-circuting of a low-voltage electric current running through the rails, by the wheels of vehicles thereon, or on what is now known as a track-circuit.

The introduction of track-circuit working gave a great impetus to automatic signalling, and it rapidly spread in the States. In January, 1902, 3354 miles, on forty different railroads, were so worked; and the system can no longer be considered as in the experimental stage. In this country it has been adopted on the main line of the London and South-Western Railway between

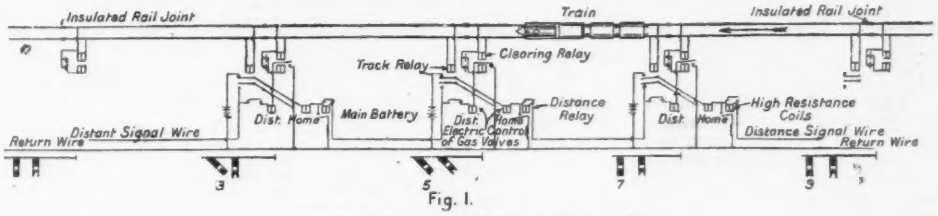


Fig. 1.

HALL'S SYSTEM, NORTH-EASTERN RAILWAY

Andover and Grateley (5½ miles), and on the North-Eastern Railway main line between Alne and Thirsk (10 miles). The latter installation is not as yet completed.

The systems in most frequent use in the United States are the electro-pneumatic and the Hall system, the latter being either electric or electro-gas. A favourite system, where economy of construction is important, is the polarised track-circuit system, which dispenses with line-wires and has motor-worked signals. A polarised relay is provided in connection with the track circuit, and a pole changer is attached to each home signal, which reverses the current in this circuit when the signal is moved, thus getting double service out of it. The Hall system is that now being installed on the North-Eastern Railway, whilst that introduced on the London and South-Western Railway is an electro-pneumatic system, differing, however, from those commonly used in the United States in that air at a pressure of 10 lb. to 20 lb. per square inch, instead of at 80 lb. or 90 lb. per square inch, is used.

In the electro-pneumatic system, power stations and air compressers are provided at suitable intervals. In an installation about to be put down on the London and South-Western Railway, one power station situated near the centre will serve for a distance of 23 miles. Pneumatic pressure is conveyed thence in pipes the whole length of the installation, with branches to all signals. Each signal arm is worked by means of a rod connected with a piston actuated by pneumatic pressure. The pressure is admitted to or withdrawn from the piston by means of a pin-valve actuated by an electro-magnet in circuit with a signal battery, which again is under the control of the track battery circuit.

The system, as carried out on the London and South-Western Railway, is "normal clear," *i.e.*, all signals stand at safety unless they are required to be at danger for the protection of occupied sections. When a train enters a section it puts to danger the signal at the entrance to that section, maintaining it in that position until it passes out of the section in advance, when the current is re-established and the arm is pulled off; there are thus two home signals, one a section behind the other, with their corresponding distant signals, to protect a train.

The system being installed on the North-Eastern Railway is that known as "normal danger," *i.e.*, the signals stand normally on, are brought to safety by an approaching train, and restored to the danger position when the train has passed—Fig. 1. Its general lines are similar to those of the London and South-Western system so far as the track and signal batteries are concerned. Special appliances have, however, to be added to effect the pulling off of the signals. The source of power also is different, as it is stored at the foot of each signal post in the form of liquefied carbonic acid gas, at a pressure of about 800 lb. per square inch, in two removable steel cylinders, to be used alternately, one being removed for filling whilst the other is in use—Fig. 2. Each cylinder of gas will suffice for 6000 to 7000 operations of the signal, and the working pressure is about 50 lb. per square inch.

The independent supply of power to each signal is probably more economical in first cost than a continuous supply of power over great lengths of line from a central power station, but whether it will be equally economical in maintenance, and equally reliable is a matter for experiment.

Both systems described are applicable to lines containing junctions and stations; and there would, therefore, seem to be an extensive field for their adoption in this country. At branch junctions no attendance would be required, except for so long as the branch line is open, and at roadside stations only when shunting is actually going on, and such attention could readily be given by the station staff.

In addition to the contact systems mentioned, and the track circuit systems with ordinary semaphore signals already described, mention should be made of other systems, such as the Miller system and the Boult system, which give their signals in the cab of the engine. The former is worked with a track circuit, and is in use in the tunnel outside the Grand Central Station at New York, and also at the west end of the Woodhead Tunnel on the Great Central Railway. Both systems can be worked with or without outside signals, but it could hardly be said that full advantage is taken of them, unless these be dispensed with; and whether this would be desirable is open to question.

The discussion which followed contained very little of interest. The audience was very small, which is a matter of surprise, as the subject is one of much importance. Mr. Wilson said that, apart from all other considerations, the use of automatic signals would effect considerable economies. They had got past the experimental stage. The Hall Company had now no fewer than 1100 signals fitted up in the United States. The electro gas signal is rapidly growing in favour. The Baltimore and Ohio Railway had adopted it to the exclusion of all other systems. As to economy, he might cite the case of what was known as "a 2½-man" signal-box. With interest, wages, &c., it represented under the ordinary system an expenditure of £238 a year. The same work was done automatically for £63 per year.

Mr. Elliott Cooper said that he was much in favour of automatic signalling for straight work, but he feared that for heavy mineral traffic it would not answer. It was too inflexible. He had more than once given inventors opportunities for trying automatic signals at their own expense, but neither they nor their friends seemed to believe in them enough to spend their own money, and he did not see why shareholders' money should be spent. Mr. Jacomb Hood said that a year's experience on the London and South-Western Railway had been attended with actually no failures at all. There were now 3000 miles of line fitted in the United States. After a somewhat desultory conversation on the meaning of the word "normal" as applied to signals, the proceedings terminated for the day.

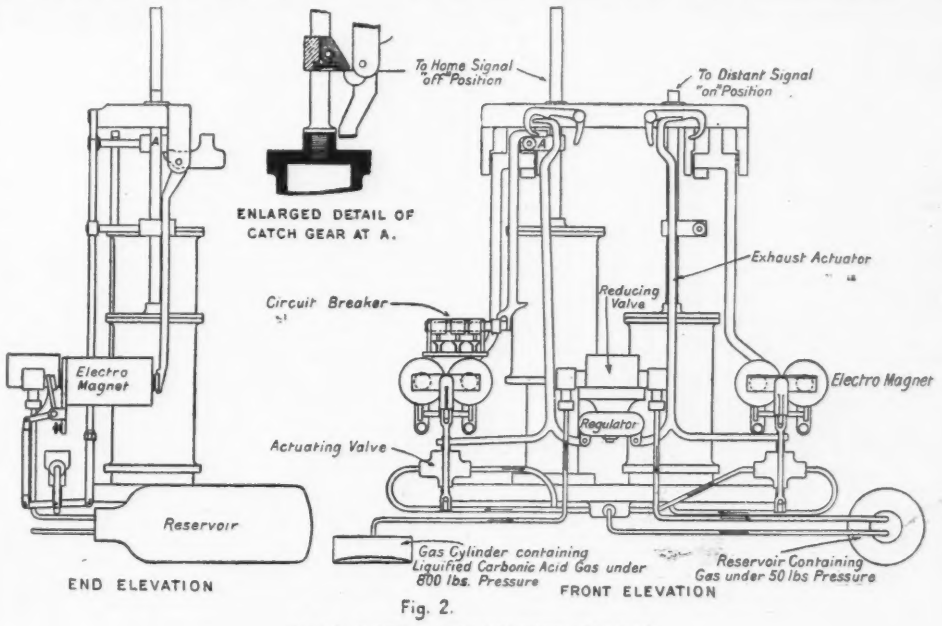


Fig. 2.

HALL'S SYSTEM, NORTH-EASTERN RAILWAY

SECTION II.

The meetings of this Section were held in the Council Chamber of the Guildhall, Westminster. The first paper read was that prepared by Mr. C. W. Darley, on

"DREDGING IN NEW SOUTH WALES."

The eastern boundary of New South Wales extends from Point Danger in the north to Cape Howe, the southern limit, a distance of about 610 miles. Some sixteen rivers, all more or less navigable, discharge along this coast, most of them passing through large areas of rich and closely-settled agricultural lands.

As the rivers form the natural outlets, and often indeed the only means, for sending produce to market, the Government have expended considerable sums in improving their navigation. A great amount of dredging has thus been involved, not only in the upper reaches of the rivers, where they are liable to shoaling after floods, but, as they nearly all have sand bars across their entrances extensive works in the way of training walls and breakwaters have been carried out to confine and direct the scour, and much dredging has had to be resorted to in straightening the channels and

deepening the bars. The circumstances and conditions connected with such dredging have rendered necessary the provision of a large and in some cases special plant for the work.

The following dredges are now available in New South Wales:—

Ladder dredges (five double and nine single ladders)	14
Grab dredges (Priestman type)	12
Suction dredges (self-propelling hopper type)	5
,, ,, (pontoon type—ordinary suction)	4
,, ,, (pontoon type with clay-cutting gear)	2
,, ,, (combined suction and grab crane type) ..	7
Total	44

all of which, with two exceptions, have been designed and built in Sydney.

The first two classes call for no special remark, as many similar dredges are to be seen working in England. One of the suction dredges named Antleon, of the self-propelling hopper type, which was designed for working on exposed river bars, is worthy of notice. This dredge was built by Messrs. Simons and Co., Renfrew, specially for bar work. The dimensions are 165ft. by 35ft. by 8½ft., and it is capable of carrying 250 tons of sand in the hopper on a draught of 5ft. The Antleon is fitted with Babcock and Wilcox boilers, supplying steam at a pressure of 150 lb. per square inch to four independent sets of triple-expansion engines; two pairs for working twin screws and two pairs for the centrifugal pumps. This vessel is reserved for deepening river bars which are liable to shoal when certain winds prevail. The dredge does not anchor, but steams slowly ahead over the bar, passing out or in, dragging the suction pipes and pumping at the same time, filling the hopper with 250 tons of sand in about twenty minutes. On one occasion, working on the Macleay River bar, 8000 tons of sand were raised and discharged at sea in 27½ working hours; and during the year ending June, 1901, this dredge raised and discharged at sea 292,850 tons at a cost of 3·49d. per ton. This includes all cost of moving from place to place, delays, and repairs, but no allowance for a sinking fund. On some occasions, when a bar has been too shallow to pass over, the vessel has had to dredge from the outside and stand out to sea or seek what shelter the nearest headland afforded during bad weather.

A fleet of some eighteen tug boats has been provided for attending the dredges, and for towing silt punts out to discharge at sea from ladder dredges, &c. Formerly much loss of time was occasioned to the ladder dredges when it was too rough on the bar or outside to tow the silt punts out. At Newcastle, where the heaviest amount of ladder dredge work had to be performed, it was estimated that some five or six weeks per annum was lost from this cause, which greatly enhanced the cost of dredging, but since the advent of sand pumps all the material raised is used for reclamation purposes, thus keeping the ladder dredges continually at work.

Very extensive reclamations are being made in Sydney at the heads of bays and other places where there are large areas of shallow water of no use for navigation purposes. A space is enclosed by a training wall, and a suction dredge is moored close by with a good length of floating delivery pipes. The dredge commences by excavating a sufficient area to a suitable depth, and the silt pumps are towed up and discharged on one side of the pump dredge a little distance off, the dredge moving about every second day to where the punts have previously been discharging, and the punts then discharge where the dredge has last been. At Newcastle an extensive island is being formed over a mud flat at the head of the harbour. Some 200 acres are being enclosed by training walls, and a large sand pump the Castor, is stationed there, landing all the silt raised by the ladder dredges. This dredge has 30in. suction and discharge pipes and engines of about 900 horse-power. During the year ending June, 1900, 1,716,573 tons of sand were landed at a cost of 0·52d. per ton, including all repairs. To give the dredge freedom to move about ample length of floating pipes is provided, the pipes being connected with gimbal joints and leather sleeves. Each pipe is about 27ft. in length and is carried on a small pontoon about 15ft. square by 2ft. in depth. The pipe is led on shore and extended by adding new pipes from day to day as the reclamation advances. The pipes are made of wrought iron $\frac{7}{16}$in. in thickness, have single-riveted seams, and are well coated with asphalt.

The dredges fitted with clay-cutting gear revolving round the suction pipes are valuable for dealing with hard deposits or for cutting new channels through tough or hard clay formations. Two types of these have been constructed, the first having the Von Schmidt system of cutting gear fitted on a pontoon 116ft. by 50ft. by 10ft. in depth with semi-circular ends. A table running on rollers and a rack is fitted at one end. This table is pivoted and is capable of being traversed from side to side round the semi-circular end. The suction pipe comes up through the centre and practically forms the pivot. On the table is carried the engine for driving the cutters, traversing gear, &c. The suction pipe crosses the table and turns down vertically, and is slung therefrom. It is telescopic, and to its lower end is attached the circular cutting frame, which is 8ft. in diameter. The cutters are driven through a 6in. vertical shaft which passes down close outside the suction pipe. This shaft, which has keyways cut along its whole length, passes freely through the centre of a large crown wheel fitted with keys to drive the shaft, and is lowered out with the suction pipes. This dredge works to a depth of 20ft., and finishes to a very uniform bottom. The table is revolved while cutting, and thus a semi-annular space 68ft. in outside diameter is cut to a level surface.

The second type of dredge has the cutters also fixed to the suction pipe, but in this case two suction pipes pass through the sides of the vessel from the pump, and are joined together in the form of a bow round the end of the hull, the suction pipe and cutting frame being fixed in the centre of the bow. The whole pipe and cutter are raised or lowered by an ordinary rope tackle, but the cutters are driven through an 8in. shaft. This has two keyways, and passes through the centre of and is driven by a large worm wheel 5ft. in diameter, the worm having a pitch diameter of 1ft. 7½in. The cutting gear for this dredge was designed by Mr. George Higgins, M. Inst. C.E., but the system for attachment was designed and the whole of the work carried out at the Government workshops in Sydney.

The total amount and cost of silt, &c., raised in New South Wales waters during the year ending June, 1900, was as follows:—

	Tons.	House dredging	Cost, pence per ton.
By ladder dredges	2,857,428	20,509	3·37
,, sand pump dredges	3,902,276	12,432	2·15
,, grab and sand pump	980,815	12,753	2·84
,, grab dredges	414,980	20,125	5·71
	8,155 499	65,819	3·33

Say 6,343,172 cubic yards at 4·28 pence per cubic yard.

It may be interesting to show how the time of the dredges is occupied on an average, as it is obvious that only for a portion of the time are they actually employed dredging.

Average for One Year's Work.

	Twelve ladder dredges.	Ten sand pump dredges.	Seven combined sand-pump and grab dredges	Twelve grab dredges.
	Per cent.	Per cent.	Per cent.	Per cent.
Dredging	63	49	61	62
Coaling	2	2	2	3
Removals	9	14	16	8
Bad weather	8	2	2	3
Waiting punts	3	—	—	2
Repairs	19	25	16	15
Other causes	1	1	3	7
Taking silt to sea	—	7	—	—
Total	100	100	100	100

The grab dredges are usually employed on the smaller rivers dealing with gravel and shingle bars. The combined pump and grab dredges are also stationed on small rivers, and are found to be a useful kind of dredge, as often hard bars of shingle are met with which the pump cannot raise, and the grab can be brought into use to clear the obstruction.

A paper by Mr. J. H. Apjohn was also read, on

"DREDGING WITH SPECIAL REFERENCE TO ROTARY CUTTERS."

The development of hydraulic dredgers has placed in the hands of engineers a tool of enormous power, and the great results achieved by them on the bars of the Mersey and other rivers are well known. They have hitherto been chiefly employed on sand or light silt, which yields to the current drawn into the nozzle by the action of the pumps. To enable a suction dredger to deal with clay, it is necessary that the clay be first cut up, as the current is insufficient to disintegrate it.

For dredging clay, rotary cutters fitted to the nozzle of the suction-pipes have been used. These consist of a number of knives—ten to fifteen—united by suitable discs or rings at one or both ends. The knives may be either straight or spiral, and are mounted around, and concentric with, the end of the suction-pipe. The whole cutter may be secured to the end of the suction-pipe, and rotary motion imparted to both together, or the cutter-shaft may be journal'ed in a suitable bearing provided in the end of the suction-pipe, which is then made stationary.

The author's experience of rotary cutters has been with a dredger designed for the purpose of excavating clay for dock extension. The clay being silty, it was thought that it would be easily broken up by the cutter, but this was not the case. The cutter had fourteen straight knives, set at an angle of 26 deg. to the tangent of the circle round which they were placed, and overlapping each other to a slight extent. The dredger was first operated at a small depth where the soil was loamy, and the cutter proved efficient, but when the cla was reached at a greater depth the openings between the blades of the cutter clogged with the tenacious plastic clay, with the result that the proportion of clay found in the water discharged through the pipe-line was extremely small. The cutter was then unshipped and a width of some inches was cut off the inner edge of each blade, so that the overlap was done away with, and at the same time the circular opening at the bottom of the cutter was reduced in area. When again tried the cutter worked better, there being but little clogging between the blades, but these did not cut the clay very well. A new cutter was then built, with narrow spiral knives, and proved to be more efficient than the first; but even with this cutter the quantity turned out per hour was never more than 60 per cent. of that contracted for. The clay which it discharged behind the walls was in the form of nodules, varying in size between that of an egg and that of a Dutch cheese. The form of the discharged clay shows that it is clay, and not, as has been asserted, silt easily disintegrated by water. If it had been the latter, it would, after passing through the pump and line of pipes, have been discharged in the form of mud, and not as hard balls, as was actually the case.

The dredger worked radially, pivoting on one of two "spuds" abreast of each other in the stern, the bow being swung by breast-lines. Having completed the arc, the other spud was dropped and the one in use was raised, so that the dredger advanced step by step against the breast she was cutting. The depth cut on each arc was about 2ft., and the bottom was left practically quite level, very different from that left by a bucket dredger. This dredger, where the material dredged is discharged directly as backing for the walls and for the raising of low land behind them, is considerably more economical than a bucket dredger, where the material has first to be discharged into barges, from which it is again carried and placed on the land.

The efficiency of a cutter evidently depends on the form of the blades, the angle at which they are set, and whether they are straight or spiral, and on the openings between them and at the bottom. To determine absolutely the best form for each description of clay to be cut would involve numerous and costly experiments which have not as yet been made.

The dredger was tried experimentally in the river to see what she could do on sand. In a depth of about 10ft. of water, and discharging back into the river through about 300ft. of floating pipe-line, she excavated 113,825 cubic feet of sand in five and a-half hours, or at the rate of 21,500 cubic feet an hour. The quantity excavated in the bed of the river was determined by soundings before and after the dredging operations. She was afterwards used for land reclamation, dredging sand from the river bed and discharging it on to the bank, through 600ft. to 900ft. of pipe, with a lift of 17ft. on an average. Under these circumstances she discharged 6500 cubic feet an hour, or 16½ per cent. in excess of the contract quantity for clay.

She was subsequently tried on improving a bar in the river, which had shoaled. The bar was about 800ft. in width, and the dredger was run three times across it on the same line, discharging to one side back into the river, through the floating pipe-line. She was only worked during such times as there was sufficient current in the river, on either the flood or ebb tide, to carry the dredgings to some distance. The operations extended over two and a-half days, and resulted in an improvement of the crossing by about 2½ft. for the width required for vessels. As the dredger was only run on one line the width to which the crossing was improved shows that the cut made by the dredger had the effect of causing the current to continue what the dredger had commenced. During these operations on the bar the "spuds" were not used, the dredger working on head and stern lines. The tendency of the cutter to cant her out of line was counteracted by a steam hopper barge lashed on one bow.

The effect on the cutters of working in sand was to wear the blades to a considerable extent, but the bearings kept in good order, the sand being excluded from them by an arrangement by which they are lubricated by water under pressure.

For working in sand, water-jets for breaking down the material to be dredged are preferred, by the engineers on the Mississippi, to rotary cutters. Interesting particulars of the dredging of this river will be found in "Notes on the Engineering Works of the Mississippi River," by E. F. Dawson, Assoc. M. Inst. C.E., Executive Engineer, Public Works Department, Bombay Presidency, published in Calcutta by Thacker Spink in 1900. Mr. Dawson was deputed by the Government of India to visit and report on the improvements on the Mississippi. At first water jets, nine or ten in number, 2¼in. to 3in. in diameter, with a pressure of 14 lb. per square inch, were used, but subsequently much better results were obtained by jets 1½in. in diameter, six in number, with a pressure of 65 lb. per square inch.

The discussion on the two papers by Mr. Darley and Mr. Apjohn, on dredging, the latter of which was read by the secretary, in the absence of the author, was opened by Mr. Vernon Harcourt, who quoted the instance of a suction dredger now in use for deepening the Saint Lawrence River, which was provided with a cutter, by the aid of which clay was drawn up through a 40in. suction pipe, and delivered on the shore through pipes 2000ft. long. He was of opinion that except when the material was to be delivered through pipes for reclamation purposes, ladder dredgers were more economical for the removal of clay and hard soil than suction dredgers.

Mr. Wheeler considered that engineers having charge of harbour works were very much indebted to the authors of the two papers for calling attention to the use of suction dredgers, where the material, instead of being carried out to sea and wasted, was used for filling up and reclaiming low land. This system had been very extensively used in America and in the Colonies, but so far as he knew it had not been adopted in this country. As an example he quoted that of the River Potomac, where clay, sand, and gravel dredged from the river for deepening the channel was driven through pipes, the longest distance being a mile. By this means over 600 acres of land had been reclaimed. In Melbourne Harbour, at Bordeaux, and at Rouen and other places, the dredgings from the river had been applied to the same purpose. The system of rotary cutters for enabling clay and hard material to be pumped up had also never been made use of in England, and therefore the description of this method was well worth the attention of the engineers attending the Conference. Suction dredgers generally have made a greater advance in other countries than in England. The largest suction dredgers here were those used in the removal of the bar of the Mersey, but on the Mississippi the capacity was exceeded by 50 per cent., one of the dredgers there being capable of lifting a maximum load of 7000 cubic yards an hour, or an average load of 5000 cubic yards. Mr. Giles, engineer to the Belfast Harbour Commissioners, stated that he had used suction dredgers discharging the material lifted through pipes for raising some lowland in the neighbourhood of Belfast, which was by this means reclaimed and let for £150 an acre.

Mr. Dobson, who had charge of the Buenos Ayres Harbour works, in support of the remarks made by one of the previous speakers as to the transporting power of the water in carrying dredged material, mentioned the fact that the quantity of material, as measured *in situ* while the dredging had been going on in the river, was over 30 per cent. greater than that actually removed in the barges, and that material consisting of clay and mud had been pumped into the channel without any shoaling being detected.

Mr. W. Matthews said that, with regard to the cost of dredging as given by Mr. Darley, this was considerably less than his experience showed to be the case at East London, where operations had to be carried on in deepening the bar, which was very exposed. In order to cope with the constant delays due to rough weather, when the dredger could not work, advantage was taken of fine weather to make a deep excavation in the sand, into which the material on the bar was carried in rough weather.

Another paper taken was that by Mr. W. T. Douglas on

"FORESHORE PROTECTION AND TRAVEL OF BEACHES."

Early in January a conference, thoroughly representative of the local authorities of the East Anglian seaboard, was held at Norwich to consider the advisability of making an appeal to the Government for assistance from the Imperial Exchequer towards the enormous cost of works of sea defence.

As an outcome of the Norwich Conference a deputation waited on the Prime Minister in March last to solicit his sympathy and aid in bringing to the notice of his Majesty's Government the fact "that the inroads of the sea upon the coasts of Norfolk and Suffolk have increased so much as to become a national danger, &c. . . . and with a view to obtaining a substantial contribution from the Imperial Exchequer towards the cost of such protective works."

With this brief summary of this question, as far as it has come into prominence with the general public, I come to the more technical matters which form the subject of these notes. They will be considered under the following general headings:—

(1) Position of the foreshore with reference to the main tidal current.

(2) Length of exposure as it affects stability of construction.

(3) Depth of water immediately below low water and in the offing, with location of neighbouring sand banks or rocks.

(4) Direction of the flood tide as it affects the travel of the beach.

(5) Nature of cliffs and beach fulls.

(6) Angle and length of groynes.

(1) Travel of beach is, on the whole, governed by the main tidal currents. The flood stream, where it impinges on a coast line, carries the beach with it in its course. Its progress is retarded very markedly, however, where the flood tide is split up by flowing into estuaries, bays, and indentations of the coast line, and in this way also its strength is reduced.

(2) The longest "fetch" or line of exposure must determine the stability of the groyne or wall. The force of the waves, which impinge on one or the other, should be calculated in pounds per square foot of exposed surface, and the design should be prepared in accordance with this calculation.

The low beach on the lee side of a groyne, which is the result of a continuance of gales acting in one direction, is frequently the main overturning factor, if provision has not been made previously for sufficient support and depth in the beach.

(3) A careful study should be made of the bed of the sea fronting the foreshore which is to be protected in order to ascertain accurately the position of channels, sand banks, &c. Channels, when heavy weather prevails, tend to draw the beach down into them, while sand banks cause the waves to break, and by so expending some of their force in the offing, their ultimate destructiveness of effect is diminished. Where a deep channe exists between outlying sand banks and the shore, it has this result, that, during on-shore gales, the course of the stream will be driven shoreward, and the beach will be pulled down into the bed of the channel. Again, a "gateway" between two outlying sand banks invariably leads the waves to the foreshore and depletes the beach which had been thus exposed.

(4) Under normal conditions, the beach travels with the flood tide. Consequently, groynes must be arranged so as to arrest the beach on their flood tide side. A gale of wind which operates in the direction of the flood tide causes a low beach to form on the lee side of a groyne placed on a foreshore, the level of the beach rising gradually in the direction of the next groyne to leeward, where its highest level is reached. A gale blowing in an opposite direction will reverse the action; but as soon as the wind drops the normal travel will be resumed.

(5) Where cliffs above high water of spring tides are friable and subject to erosion, a sea wall is a matter of necessity, since it is the only means of preventing the denudation of the cliff, and constitutes a protection against the beach being driven by the force of the waves around the upper extremity of the groyne. A sea wall, where the waves impinge upon it, will by itself bring about the denudation of a foreshore. The process will be more rapid in places where the waves strike the wall at a low angle with the shore. If high groynes, placed at short distances apart, abut on a wall, they minimise the tendency of a sea wall to produce a scour, as they break up the force of the wave action. The height to which beach is driven by very severe onshore gales when contemporaneous with spring tides remains constant. Where beach continues to advance seaward the level of the "full" does not alter, and of the truth of this Dungeness Point affords one proof amongst many. Here the beach has advanced seaward from Lydd, a distance of three miles, the surface being in one plane. The height of these fulls should not be exceeded by the height of a groyne where it terminates against a wall or cliff, unless a heavy

DOVER HARBOUR WORKS

(*For description see page 610*)

ADMIRALTY PIER EXTENSION

EAST ARM AND TEMPORARY STAGING, JULY, 1902

scour on its leeward side is a matter of no importance. Spur groynes placed on the leeward side of a breakwater or pier will be found useful in accumulating beach. This they do by causing an eddy tide on their shoreward side, and by driving the flood tide seaward off the foreshore.

(6) The collecting capacity of any groyne may be measured in terms of its length seaward. Beach and sand are swept along a foreshore, and are carried over the bed of the sea by the action of the waves. When checked by the surface of groynes they move shorewards. Hence the deduction follows that the greater the length of the groyne the greater will be its utility in accumulating beach and in buildiug up foreshore. The best angle at which to construct a groyne is approximately at 95 deg. to the flood tide, or at 85 deg. from the shore. Any diminution of this angle will shorten the length of the groyne seaward, and permit the littoral drift to pass its extremity. It can be demonstrated easily that the lengthening of a groyne has produced invariably a useful and noteworthy effect, by driving back the high and low-water marks on a foreshore. Where the foreshore is short it is not enough merely to construct a groyne between the cliff or sea wall and low-water mark. A groyne so limited in length results generally in a low or channel at the seaward end, and one of two things will probably happen. Either the groyne will be overturned into the channel or the beach will be pulled down into deep water. Extension beyond low-water mark may best be carried out by driving sheet-piling from an overhead gantry, the gantry piles subsequently forming stays to which the sheeting is braced. In this manner groynes 300ft. to 500ft. in length can be constructed at a moderate outlay, without serious inconvenience from loss of time. This mode of construction may be employed where low-water mark stands against the cliff or sea wall.

The effect of groynes generally is to produce a more or less sheltered area, where littoral drift, freed from the turbulent action of the waves, tends to deposit itself. From this the conclusion may with safety be drawn that, within certain limits, and if allowance is made for a sufficiency of travel, the greater the sheltered area the larger will be the desired result.

The discussion on this paper turned chiefly on the statement that littoral drift was due to tidal action, Captain Frederick, of the Harbour Department of the Board of Trade, Messrs. Sandeman, Grantham, Vernon Harcourt, and W. Matthews expressing the opinion that the movement was entirely due to wave action caused by the prevailing winds, while Mr. Wheeler supported the author's views. Mr. Grantham also challenged the author's views as to the angle that groynes should be placed with the shore, saying that in his experience this should not be less than 60deg. Mr. Davidson condemned the system of using high groynes, and thought that these should not exceed the height at which the shingle was naturally deposited, and in his experience there was no need to place groynes nearer together than 600ft.

The proposition made by the deputation that lately waited on the Prime Minister with the object of trying to get the Government to take up the works necessary for the protection of the sea coast was almost unanimously condemned by all the speakers, and it was pointed out how unfair it would be to draw money from inland places in order to maintain promenades and other works that had been constructed for the development of seaside resorts.

SECTION III.

The meetings of this Section were held in the hall of the Institution of Mechanical Engineers, under the presidency of Dr. Kennedy. The first paper taken was by Mr. A. P. Head, on

"SPEEDS OF OVERHEAD AND OTHER CRANES AS A FACTOR IN ECONOMIC HANDLING OF MATERIAL IN WORKING."

The author dealt almost exclusively with electric cranes. The most suitable form of electrical energy is continuous current, at 220 volts to 500 volts. This is superior to alternating current on account of the greater starting torque and acceleration given by the former. The operations of a crane involve a rapid succession of startings and stoppings; continuous running occupies an unimportant fraction of the time, and loads are very variable. Alternating-current motors, while efficient at full loads, can only have a strong starting torque at the expense of efficiency. Continuous current, on the other hand, admits of easier regulation of motors, is cheaper in wiring, and can be stored in batteries to equalise a variable load. Series-wound motors, which automatically run faster with lighter loads, should be used if they are coupled permanently to the gearing. They should withstand 100 per cent. overloading for short periods, and much higher overloads momentarily without damage, which conditions are fulfilled by the ordinary tramway type. Where motors run continuously with clutch-connections to the gearing they should be shunt-wound.

The proper speeds for a crane depend on the purpose for which it is intended. The ideal condition is rapid acceleration, uniform motion at a high speed, and quick slowing down. Rapid acceleration can be obtained by employing series-wound motors, if permanently coupled, or the inertia of a continuously-running motor if working through clutches. Quick stopping is effectively achieved by an electric brake working on the armature shaft, operated by a weight or spring, and taken off by a solenoid in series with the motor. Such a brake is of almost universal application to the hoisting motor, and serves not only to prevent the load accidentally running down, but to stop the motor quickly, giving to the motion the exactitude and precision characteristic of hydraulic cranes. Most cranes are fitted with an additional mechanical brake, which prevents the load descending fast enough to drive the motor.

(*a*) *Fixed jib cranes.*—With these may be included those mounted on a carriage and having slow travelling motion not in constant use. Great speeds are necessary when jib-cranes are used for loading and unloading ships. In the latest practice hoisting is done by the hoisting motor through a friction clutch, and lowering by the foot-brake. An electric brake stops the motor when the current is cut off, but the hoisting drum is disconnected and lowering is accomplished independently of the motor, which need not reverse. In a typical 3-ton dock crane of English make, the cycle of lifting, slewing, lowering, and slewing back is performed in forty-three seconds. In another recent instance of a 3-ton crane the lifting speed is 150ft. per minute, and the slewing speed is three complete revolutions per minute. Derricking is more common in England than abroad, and may be done at slow speeds by a small motor. A single hoisting rope is preferable for operating light loads quickly. Slewing is done by a separate motor.

(*b*) *Fixed votary cranes.*—These are usually for heavy loads where speed is unimportant.

(*c*) *Overhead travelling cranes.*—These are used in steelworks, engineering shops, foundries, &c., and should have a separate motor for each of the three motions, controlled by an operator at one end of the bridge. If lateral motion is effected by a continuously-running motor and clutch gear, the suddenness of starting sets up swinging of the load, which is obviated by the more gradual acceleration of separate motors. The longitudinal travelling is usually the quickest motion, as the distances covered are relatively great. If the load is habitually lifted by a sling, and if a single slinger is employed, the longitudinal speed is limited by the speed at which he can walk from one point to the other, and it is useless to exceed this. Assuming the slinger to walk at four miles per hour, or 350ft. per minute, he should start as soon as the load leaves the ground, and should be at the depositing point when it nearly touches the ground. His presence is unnecessary during most of the actual lifting and lowering. The crane should, therefore, travel faster than the man, and should overtake him half way. The maximum useful speed is thus 400ft. or 450ft. per minute, depending on the average run. With a practised operator, cross-traversing takes place simultaneously with longitudinal travelling, and occupies no extra time.

In the latest American practice two slingers are employed, one at each end of the shop, rendering much higher speeds possible. In one instance longitudinal travel is at the rate of 800ft. per minute, and cross-traversing at 250ft. per minute.

If the crane is of large capacity an auxiliary hoisting drum or an independent trolley for light loads saves both power and time. In Table I. are given the speeds of typical modern cranes for shop purposes, by both English and American makers, and indicates that English speeds are still considerably below American.

A mechanical efficiency of 66⅔ per cent. in the lifting mechanism may be assumed with good workmanship, and if only spur gearing is used. Worm gearing reduces this by about 10 per cent. under the best conditions, and is popular in Germany, although not considered good practice in England or America. Longitudinal travelling is much accelerated by having the runway track smooth, designed to resist lateral stresses equal to one-fifth the capacity of the crane. The bridge tracks should be designed to resist lateral stresses equal to one-fourth the capacity of the crane.

The longitudinal and cross-traversing gears are sometimes provided with electric brakes to prevent over-running, thus imparting a feeling of confidence to the operator and enabling him to work at higher speeds. In calculating the brake horse-power of these motors, a tractive force of 50 lb. and 35 lb. per ton of total weight should be assumed for longitudinal and cross-traverse respectively, assuming level tracks, and spur gearing, and reasonably large track wheels.

(*d*) *and* (*e*) *Gantry and cantilever cranes.*—These differ chiefly in the gauge of the ground track and the consequent design of the bridge, the former being wide and the latter narrow-gauge. They are generally of large dimensions, and are used for moving materials from one point to another in an open space, or for shipbuilding purposes. The mechanism is arranged on either of two systems. In the first, the operator's cage is attached to the main structure, and contains one motor with reversing clutches for operating the various drums, motion being transmitted by ropes. This gives a light trolley with power to start and stop almost instantaneously, and rapid motions in all three directions. But the complication of ropes is an objection, and the operator is badly placed for overseeing the work. In the second system, the operator's cage is on the trolley, and he is always over the hook. This does away with all ropes except for lifting, but makes the trolley heavy, owing to the weight of the two motors and gearing. The whole structure must, therefore, be stronger. Opinion s divided as to which system is best.

The following speeds are typical of a shipbuilding cantilever crane actuated by ropes and clutches. Hoisting speed, with 13 tons, 125ft. per minute; with 4½ tons, 350 tons per minute; with ½ ton, 750ft. per minute; trolley traverse, 400ft. to 800ft. per minute, according to load. Longitudinal travel, 400ft. to 700ft. per minute. In some cases the trolley traverse reaches 1200ft. per minute, and the longitudinal travel 900ft. per minute.

The following speeds are typical of a 5-ton yard cantilever crane of 200ft. span, with a motor for each motion, and two out of three motors and gears carried on the trolley. Hoisting speed with full load, 100ft. per minute; longitudinal travelling, 300ft. per minute.

For shipbuilding and other purposes, where the longitudinal travelling is important, the author suggests that better service at less cost may be obtained by two or more light, rapid cranes of small capacity on parallel overhead runways.

Gantry cranes, with or without an added cantilever, are largely used for unloading minerals in buckets from ships or stock piles, and are made in England, America, and Germany. Longitudinal travel need not be rapid, being seldom used, but lifting and cross-travel are very rapid, and are operated by one motor through clutches and ropes. The bridge is frequently inclined towards the ship or picking-up point in order to use gravity, assisted by a counterweight and tail-rope, in one direction, the speed being checked by a foot-brake. Remarkable speeds are obtained by these means. A complete cycle of operations, including delivery of the bucket to the end of a 200ft. bridge, can be performed in one minute. The speed of the trolley uphill with full bucket is 800ft. per minute, and the return speed downhill is 1000ft. per minute.

TABLE I.

Speeds of Electric Overhead Travelling Cranes (Sundry English Makes).

Lifting capacity.	Speed with full load in feet per minute.			
	Hoisting.		Cross traversing	Longitudinal travelling.
	Main.	Auxiliary.		
Tons.	Ft. in.	Ft.	Ft.	Ft.
100	3 6	14	50	80
100	2 0	7	50	60
50	6 0	24	70	125
50	3 0	80	40	80
40	3 0	—	50	80
20	10 0	40	100	200
10	10 0	—	60	150
5	20 0	—	60	150
3	30 0	—	60	150
3	30 0	—	160	325

American practice.—The usual American practice for shop cranes is:—Longitudinal travelling, 500ft. to 450ft. per minute; cross traversing, 100ft. to 150ft. per minute; and hoisting, 10ft. to 50ft. per minute, according to the capacity.

The Brown Hoisting Company have constructed ore-unloading machinery at West Superior, having an automatic grab bucket of 1½ tons capacity. The lift is 40ft., and the delivery point is 150ft. from the wharf edge. A complete cycle of operations is performed in 30 sec., and 1000 cycles have been done in 10 hours, including moving the machine from hatch to hatch.

A new development in America is to fit such gantry cranes with independent motors and a "man-trolley," which carries the operator and also the hoisting and traversing motors and gears. In one plant now being constructed, the trolley is designed to support a grab bucket of 8 tons capacity for iron ore. The loaded trolley will weigh 35 tons, and will carry machinery of 500 horse-power. It is intended to travel on a horizontal bridge at 1000ft. to 1200ft. per minute, and to hoist at the rate of 300ft. to 350ft. per minute.

TABLE II.

Speeds of Locomotive Cranes (American).

Lifting capacity.	Speed with full load in feet per minute.		Speed of slewing. Complete revolutions per minute.
	Hoisting	Travelling.	
Tons.			
2	135	520	6
5	75	460	5
10	42½	500	4
20	25	500	2½

A still later development is to place the operator on the trolley, but without any driving mechanism. All motors, gearing, driving drums, and controllers are situated in a house attached to the main structure. The operator, from his position on the trolley, works the controllers through miniature controllers, somewhat after the manner adopted in an electric elevator. By this system the combined advantages of a light trolley, and perfect supervision of his work by the operator, are obtained.

(*f*) *Locomotive steam cranes.*—These are largely used and deservedly popular because of their mobility on an ordinary track without electrical connections. The boiler is used as a counter-weight, and one pair of engines operates the lifting, slewing, derricking and travelling motions through clutches. Typical speeds of such cranes of American manufacture are given in Table II.

The discussion was opened by Mr. Matthews, who called in question the accuracy of the efficiency of electric cranes given by the author, and quoted figures from a paper he read before the Manchester Association of Engineers, on March 8th, 1902. These figures showed that for the great majority of cases nothing like an efficiency of 66⅔ given by Mr. Head is obtainable. Every crane has a certain speed and lift at which it is more efficient than at any other speed and lift, and this economic law has to be borne in mind when the power of a crane is being decided upon. In a certain 50-ton crane, on which he had made experiments, the maximum efficiency occurred with a load of 20·7 tons, and fell as the load increased; at 31 tons it was 58 per cent., and at 44 tons it was only 45 per cent. In the cases of a bigger crane, 70 tons, the point of greatest efficiency was with a load of 20·3 tons, lifted at 3·75ft. per minute. This crane was driven by clutch and spur gear. In another case, owing to the fact that the clearance between the drum and brake block was too slight, the maximum efficiency only reached 30 per cent. He mentioned these figures because he felt that if anyone were to design a crane on the assumption that it would work at an efficiency of 66 per cent., would fall into serious error. With regard to worm gearing, although he did not believe in its use, yet he had figures of a case where it gave a maximum efficiency of 66·7 per cent. with a load of three tons, falling to 59 per cent. with a load of five tons.

Mr. Ellington also supported the view that 66 per cent. was too high a figure for an electric crane. In most cranes of this kind several small electric motors were used, and unless they were exceptionally efficient such a result could not be obtained. The kind of crane that should be used depended on the conditions. If the loads to be lifted were fairly constant, then an hydraulic crane probably gave the best result, and an efficiency of over 66 per cent. was occasionally obtained, but this efficiency fell if the loads were variable. There was, however, this in favour of the hydraulic crane, that an accumulator could be used with it, and its value as reducing the power that had to be developed at the central station was enormous. He would like to have heard some discussion on the commercial value of speed in handling materials. Undoubtedly in many cases it was of great advantage to be able to work quickly, but no precise value that could be contrasted with its cost had ever been found for speed.

Professor Jamieson took a position strongly in favour of electric cranes, and cited some comparative tests that had been made as to the cost of discharging 1000 tons of cargo by hydraulic and electric means. He gave the following figures:—

Loads lifted—1	2	2½	3
	s. d.	s. d.	s. d.	s. d.
Price—hydraulic...	48 3	25 5	20 6	17 2
Price—electric	15 11	16 2	16 1½	16 6½

This table called first Mr. Henry Davey to his feet to inquire as to the power of the hydraulic cranes, and then Mr. Arthur Tannet Walker to repeat this inquiry and to ask in addition how old the crane was. To these Prof. Jamieson replied that the crane was made in 1897, and was a two powered crane of 2 and 5 tons. The electric crane was made in 1902. Mr. Walker claimed that the comparison between a new electric crane and an old hydraulic was unfair, and was doubly unfair when the hydraulic crane was not used at its best power. Professor Jamieson further stated that taking the efficiency over a period of six months it worked out to 77 per cent. for the electric and only 58 per cent. for the hydraulic.

Mr. Stothert also spoke in favour of electric cranes, especially where variable loads had to be dealt with. This was the case with wharf cranes, on which he estimated that the average load was not more than 15 cwt. The speed was regulated by the rate at which the stevedores and labourers could work the cargo. The lift was generally from 150ft. to 200ft. per minute for a 3-ton crane, with a speed of 400ft. revolving at crane hook, which permitted of about seventy cycles an hour if the labour was sufficient.

Mr. Head was then called upon to reply, and the principal point of his remarks was that the 66⅔ per cent. efficiency about which there had been so much discussion, was, as clearly stated in the paper, mechanical efficiency only, that is to say, that the calculation was on the basis of the brake horse-power of the motors.

(*Continued on page 627*).

THE INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES ASSOCIATION.—The summer visit of the Graduates' Association took place on Wednesday, June 10th, when the London and South-Western Railway Carriage and Wagon Works, at Eastleigh, and the Cold Storage and Dock Improvement Works at Southampton, were visited. The party, numbering about twenty-five, left Waterloo by the 9.20 a.m. train, arriving at Eastleigh at 11.30, where they were met by the London and South-Western Railway representatives, and conducted over the works. About two hours were spent here, and train was taken to Southampton docks. The Dock Improvement Works were visited, where the ferro-concrete work was inspected with great interest. After some time had been spent here the party passed on to the cold storage works, which are believed to be the largest in the world. The annual business meeting was held on Monday, June 15th. During the past session the number of graduates added to the list has been about 80, the total number amounting now to over 400. There has been a very satisfactory increase in the attendance at both visits and meetings.

RAILWAY MATTERS.

THE North-Eastern Railway directors have accepted tenders for the station buildings, station masters' houses, cottages, weigh offices, and other works on the new line now constructing between Gosforth and Ponteland.

THE Piræus Frontier Railway is being actively proceeded with, and by the end of the year it is hoped that it may be open to traffic as far as Levadia, thus proving a great benefit to the Lake Copais district, through which it passes.

THE trial trip of the first cross-Channel turbine steamer the Queen, built for the South-Eastern and Chatham Railway, originally arranged for to-morrow—Saturday—from Folkestone Harbour to Calais has been postponed till next week.

A RETURN giving dates of purchase and prices paid for rails, sleepers, girders, locomotives, carriages, and bridgework obtained for the construction and working of the Uganda Railway has been presented to the House of Lords and published.

THE Great Indian Peninsula Railway Company, on April 16th, celebrated the jubilee of its opening fifty years ago, when a section of the line from Bombay to Tanua, a distance of 21 miles, was completed. At the beginning of the present year 25,936 miles of lines were in use.

WE regret to have to record the death from peritonitis of Sir Joseph Loftus Wilkinson, general manager of the Great Western Railway. Sir Joseph Wilkinson was born in 1845. Educated at Reading School, he started his railway career as a booking clerk, and became general manager of the Great Western Railway in 1896. Sir Joseph Wilkinson was a member of the Institute of Civil Engineers. He was created a knight last year.

THE passenger traffic on the Victorian railways is far ahead of that in the other States, but this is entirely due to the splendid suburban railway system of Melbourne. In Sydney, on the other hand, the greater part of the suburban traffic is carried over the city and suburban tramways. The total length of tramways, including those of the city of Newcastle—14 miles—was, on June 30th, 1902, 104 miles; of this mileage about 38 miles are worked by means of steam power, 2 miles 32 chains by cable, and about 64 miles by electricity—overhead system.

THE distance by rail from Brisbane to Adelaide is 1782 miles, and the journey occupies—including a stoppage of 8 h. 7 min. at Sydney, and one of 4 h. 10 min. at Melbourne—75½ hours, allowing for the difference in time. A traveller leaving Brisbane at 7 a.m. on Monday will reach Adelaide at 10.14 a.m. on Thursday. The distances between the capital cities and the times occupied for the journeys are as follows:—Brisbane to Sydney, 723 miles, 27 h. 58 min.; Sydney to Melbourne, 576 miles, 17 h. 15 min.; Melbourne to Adelaide, 483 miles, 18 h. 14 min.

THE French engine being built by M. de Glehn for trial on the Great Western Railway will, in all probability, not be delivered in this country until September. After it has been put together at Swindon the *Western Morning News* understands that it will be tested against one of the latest pattern Swindon-built engines, the French engine being handled by Frenchmen only, so that the test may be fair in every respect. M. de Glehn's engine is not intended primarily to cope with stiff gradients, so that it is improbable that it would be run further west than Exeter should the Great Western Railwaymen find it superior to their own make for work between London and Exeter.

REUTER'S Agency has received intelligence from Eldoma Ravine, British East Africa, that the Nandi tribe were continuing to give a good deal of trouble on the section of the Uganda Railway between Fort Ternan and Muhoroni stations, some 40 or 50 miles from Lake Victoria. Full details are not yet to hand, but it appears that a conflict had taken place in which two Sikh soldiers and five coolies had been killed by the natives and a number wounded, and that work had been stopped on the railway for a distance of 30 miles. A force had been despatched from Nairobi to the disturbed district. On the 2nd ult. a train was derailed three times between Londiani and Kisumu.

A SCHEME is on foot in New Zealand for working the railways in North Island by electricity derived from water power. The Huka Falls, estimated to yield 39,000 horse-power, would be utilised for this purpose, and power distributed throughout Northern New Zealand for use in the industrial centres. It is proposed to distribute power in four directions—*i.e.*, one north, to Auckland and the Thames; one south, to Wellington and the provinces; one to Tarakaki, and one to the Napier district. It is said that the electrical energy developed would be sufficient to work the whole of the railways in the North Island, and leave 30,000 horse-power for distribution for industrial purposes.

THE number of persons carried daily by the Manhattan elevated railroad now averages 800,000, and to work the service 45,000 electrical horse-power is required. Since the system has been converted from a steam to an electrically-operated line the average speed of the trains has been accelerated about 25 per cent. The gain in speed is chiefly in the rapid acceleration at starting and quicker stopping. The speed of the train when under way is also higher than it was when steam locomotives were in use. There is a further gain due to the fact that in the busy hours the trains are six cars instead of five cars in length, there being a further increase in capacity of 20 per cent. from this cause alone.

THE tramways of New South Wales are managed by the Railway Commissioners. One hundred and twenty-two miles of line are open, and the earnings for the quarter ended March 31st last amounted to £199,789, and the expenditure to £156,987. The earnings increased by £26,912, and the expenditure by £25,315. Sixty-eight miles of tramway are operated under the electric system, fifty-two miles by steam motors, and two miles by cable; but the ultimate object is to convert the whole of the metropolitan lines to the electric system. The passenger journeys made during the three months totalled 35,000,000, showing an advance on the figures for the corresponding period of the previous year.

ONE of the inspectors under the Board of Trade, Major Pringle, made the final inspection on Tuesday of the electrical equipment of the new portion of the District Railway Company between Ealing and South Harrow, which will be opened to the public on Monday. The new line is about five miles in length, and brings Harrow, Sudbury, and Alperton into direct and easy communication with the City. In all there will be six stations on this new line, viz., South Harrow, Sudbury-hill, Sudbury town, Alperton, Park Royal, and North Ealing. Park Royal will serve the new show ground of the Royal Agricultural Society. The trains which are to be used on the new line will be made up of four coaches, with a motor at each end and one in the middle.

THE main line engines of the Natal Government Railways are being worked to their outside capacity, a large proportion now running with double and in some cases three shifts of men. An increase in the motive power is contemplated if the present heavy tonnage is to be maintained. Provision has consequently been made in the estimates for a further supply of locomotives. The locomotive superintendent is designing a passenger engine to deal with the heavy traffic now falling to be worked over the main line at the speed authorised for the passenger service, but it is thought that the maximum weight of an engine which can be worked over the 3ft. 6in. gauge has been reached. It is worthy of notice that the engine which was employed for heavy traffic during the last year is believed to be the heaviest engine running upon a 3ft. 6in. gauge line in the world.

NOTES AND MEMORANDA.

THE battleships Mars and Hannibal, which have half their boilers so fitted as to use coal or oil fuel alternatively or together, are to have the whole of their boilers so fitted. The experiments in the two battleships have not resulted in an appreciable diminution of smoke from the funnels; but the speed and endurance results from oil are said to be highly satisfactory.

IN her trials on June 4th the French battleship Suffren made use of an apparatus to regulate the stoking, invented by M. Merlu, chief engineer in the French navy, which, it is said, owing to the good results obtained from its use in this and in other vessels, will probably be adopted throughout the French navy. The trials of the engines and boilers were quite satisfactory.

THE first complete financial year of the Glasgow Corporation telephone undertaking was completed on May 31st, when 9122 telephones were in connection with the Exchange. As the number estimated for that date by the general manager was only 9000, it will be seen that the estimate was more than justified. In addition, there were orders on hand for about 800 more instruments.

RECENT experiments are said to have shown that an extract of straw mixed with clay renders this material much more plastic, and gives it a greater tensile strength, thus justifying the Egyptians in their use of straw. It is no longer necessary to assume that the benefits derived by them was due to the presence of the straw fibre, but rather to this, as yet, mysterious effect of the extract.

A TABLE of efficiency of Admiral Noel's Home Squadron in heavy gun shooting for 1902 has been communicated to Mr. Arnold White by a naval official for publication. The average figure of efficiency for the British fleet in 1901 was about 33 per cent., or two misses for every hit. The table shows that the efficiency of the Home Squadron last year was four misses for one hit. The number of rounds fired was 1096.

A SMALL winding engine was erected by the Corporation electricity department at St. Helens at a very small colliery, the depth of the shaft in this case being about 70 yards, and the amount of coal wound daily during ten hours was about 60 to 70 tons. About the same time a similar small colliery was started with steam winding; the amount of coal in this case was about the same, the depth of shaft being slightly greater. The cost of winding per ton electrically, at 2d. per unit, worked out at one-fifth the cost of winding by steam.

AT the Local Government Board inquiry as to proposed extension of the area over which the Port Sanitary Authority of London exercises jurisdiction in regard to food inspection, some very interesting evidence was given. The City Solicitor stated that 16,432,237 packages of food stuff were inspected in the docks and in the river during 1902. The total yearly deliveries of tinned food at the nine riverside wharves in the City were 13,261 tons. The weight of meat delivered by water to the six cold-air stores at the riverside during the first four months of the present year was 19,876 tons.

THE Memorandum prepared by the Labour Department of the Board of Trade for the *Labour Gazette*, states that employment in May showed little change on the whole as compared with April. As compared with a year ago employment continues to show some falling off. In the 226 trade unions, with an aggregate membership of 554,524 making returns, 22,102, or 4·0 per cent., were reported as unemployed at the end of May, as compared with 4·1 per cent. in April, and 4·0 per cent. in the 224 trade unions, with a membership of 549,023 from which returns were received for May, 1902.

DURING a recent severe thunderstorm in London alarming electric discharges took place over the two large telephone switchboards at the Southwark headquarters of the Metropolitan Fire Brigade over which news of calls from all parts of London is transmitted. It was reported that no apparent damage was done to the apparatus, and it was fortunate that there were no messages calling for attention during the time the discharges induced by the storm were taking place amongst the instruments. The *Lancet* suggests that both telegraphic and telephonic services may become a source of danger during great electrical stress in the air, and persons should be warned against using the instruments at such a time, and certainly when alarming symptoms of a storm are manifest themselves in the way just described.

EVEN at the present day in certain relatively very small units, the internal combustion engine, such as the gas or oil engine, has shown efficiencies nearly double that of the best steam engine plant and the partial load efficiency is also satisfactory. There can also be no question that the internal combustion engine is susceptible of improvement, so that in large units the present efficiency will be far surpassed. Professor Elihu Thomson, in a paper recently read at Chicago, gives it as his opinion that it is probable that an efficiency of heat conversion up to between 40 and 50 per cent. will some day be practicable, a result about three times better than is attained with steam. The engines which would be used would naturally be of large reciprocating type and comparatively slow speed, unless some form of gas turbine be developed.

ACCORDING to the Astronomer-General's report for the year 1902, the automatic signals from the Westminster clock were received at Greenwich throughout the year except on eleven days, when the signal failed, and during the month of January while the clock was being repaired. The apparent error of the clock was not greater than 0·5 sec. on 21 per cent. of the days of observation, not greater than 1·0 sec. on 39 per cent., not greater than 2·0 sec. on 68 per cent., not greater than 3·0 sec. on 90 per cent., not greater than 4·0 sec. on 96 per cent., and exceeded 4 sec. on eight occasions. It is understood that the performance of the clock has been affected by bricklayers' work in the weight shaft in connection with electric lighting last October, and that the cleaning of the clock which was thus rendered necessary had to be deferred till the Parliamentary recess.

A NEW form of stereoscope for X ray work is described by M. T. Guilloz in a recent number of the *Journal de Physique*. A single X-ray tube is used, being so mounted that it can be rapidly oscillated between two positions. A cam rotating at a speed of about 300 revolutions per minute is used to oscillate the tube; this cam is cut so that the time taken in moving from one position of rest to the other is about one-tenth of the time of rotation. Two radiographic images of the object under examination are thus formed on the screen, which are displaced by an amount varying as the amplitude of oscillation of the tube, and its distance from the screen. Two shutters, controlled electromagnetically by the oscillating apparatus, allow the right eye to view one image and the left the other, vision being entirely cut off during the time the tube is changing its position.

IN Germany 30,000 tons of tin-scrap are now worked up annually in seven factories operating the electrolytic process, metallic tin being recovered. Although the use of other electrolytes has been proposed and patented, sodium hydrate is stated to yield the best results. In Austria one tin recovery works is stated to be in operation; and England possesses one small experimental plant at Manchester. Germany at present is drawing supplies of scrap for the seven works referred to from England, France, and Switzerland, the home supply proving insufficient to meet the requirements of the works. This state of things is unlikely to continue, says the *Iron and Coal Trades Review*, and it is evident that a well-situated electrolytic recovery works, with a good organisation for the collection and transport of the scrap and cuttings, is demanded, and will some day be found in operation.

MISCELLANEA.

LEEDS Corporation tramways have made a profit of £62,000 during the past year, which is equal to a rate of 8d. in the pound.

THE Italian Legation has begun an installation of the Marconi system at Peking to communicate direct with ships in the Gulf of Pe-chi-li.

COLONEL EXHAM, R.E., Superintendent Engineer at the Naval Works, Portsmouth District, has been appointed to a similar post at St. Margaret's Hope, the new naval base in Scotland.

THE cruiser Donegal, built by the Fairfield Shipbuilding Company, Glasgow, will commence a series of trials at Fairfield on the 22nd inst., and is expected to arrive at Devonport on or about the 28th inst. for gun, torpedo, and other trials.

THE Bridges Committee of the London County Council has written to the Woolwich Borough Council regretting that, owing to the County Council's heavy commitments, it cannot proceed at present with the scheme for a subway under the Thames at Woolwich.

WE regret to have to record the death of Mr. George Meakes, head of the firm of Meakes and Redknap, the Thames launch and boat-building firm. Deceased was one of the founders, and for several years honorary secretary of the Thames Boat-builders' Protection Association.

A SERIOUS explosion took place at Woolwich Arsenal yesterday morning, whereby fifteen men lost their lives and eighteen were injured, four seriously. The accident occurred in the lyddite factory, and it is at present attributed to the bursting of a shell, but at the moment of going to press information is limited, and its correctness open to serious question.

ON Saturday the turbine passenger steamer Brighton, built by Messrs. William Denny and Brothers for the Newhaven-Dieppe service of the London, Brighton and South Coast, and Western of France Railways, was launched from the Leven shipyard, Dumbarton. The boat will, it is expected, be placed on the cross-Channel service in the course of a few weeks.

THE Dominion Government have decided not to accept either of the two tenders received for a fast Atlantic service between Canada and Great Britain, but they will use them as a basis for further negotiations, according to a Reuter telegram from Ottawa. The Senate demurs to granting a charter to the new Canadian company on the ground that the claims set forth in the prospectus may mislead English investors.

WE learn that the Thames Steamboat Service Company, which was formed a few weeks ago, mainly through the exertions of Mr. L. S. Bickley, of Greenwich, with the object of providing a steamboat service on the Thames between Greenwich and Westminster, has been unable to go to allotment, an insufficient number of shares having been taken up. The amount of capital decided on was £4000, and the shares taken fell short of this by about £1000.

IT is proposed to make an attempt to render Cadiz the European port for South Africa, in the same manner as Brindisi now is for the East. By this means it would, it is said, be possible for the mails to be delivered in London two days sooner than they are at present. For passengers also the saving of time and sea voyage would be an appreciable gain. Of course, amongst other things, the scheme depends upon an improvement in the train service between Cadiz and Madrid. The Spanish Government are, it is said, favourable towards the project.

WE understand that the Earl of Leitrim is organising a motor car service in the North-West of County Donegal, Ireland. The first service to be opened will be between Strabane Railway Station and Rosapenna, a distance of thirty-eight miles. At Strabane the autocar service will make connections with trains from Belfast and Dublin, and with those of both the Great Northern and Donegal Railways by way of Londonderry. The service will be timed to suit the cross-Channel services with England and Scotland. The cars will carry sixteen persons, and will be provided with 27 horse-power engines.

THE new electricity works of the Mansfield Corporation were opened on Wednesday. Continuous current at 480 volts between the outers is distributed by 8·7 miles of triple-concentric lead-covered cables. Five boilers—two Babcock and Wilcox and three Lancashire—having a total evaporative capacity of 32,000 lb. of water per hour, supply steam to three Alley and Maclellan double-acting high-speed three-crank triple-expansion engines, whose aggregate indicated horse-power is 1000. Coupled to the engines are three Parker multipolar dynamos with a combined capacity of 600 kilowatts.

COPENHAGEN possesses a very complete and extensive system of tramways. The power is delivered from the overhead trolley system, and storage batteries have been entirely done away with, and horse traction is being gradually abolished. Any distance from one to five or six miles can be travelled for 1d., and transfer tickets enabling passengers to change cars are supplied free. The working expenses are about 7¼d. per mile. The tramways belong to a company, which has a forty years' lease from 1898 from the municipality, and the municipality has the right to buy the various lines in 1908.

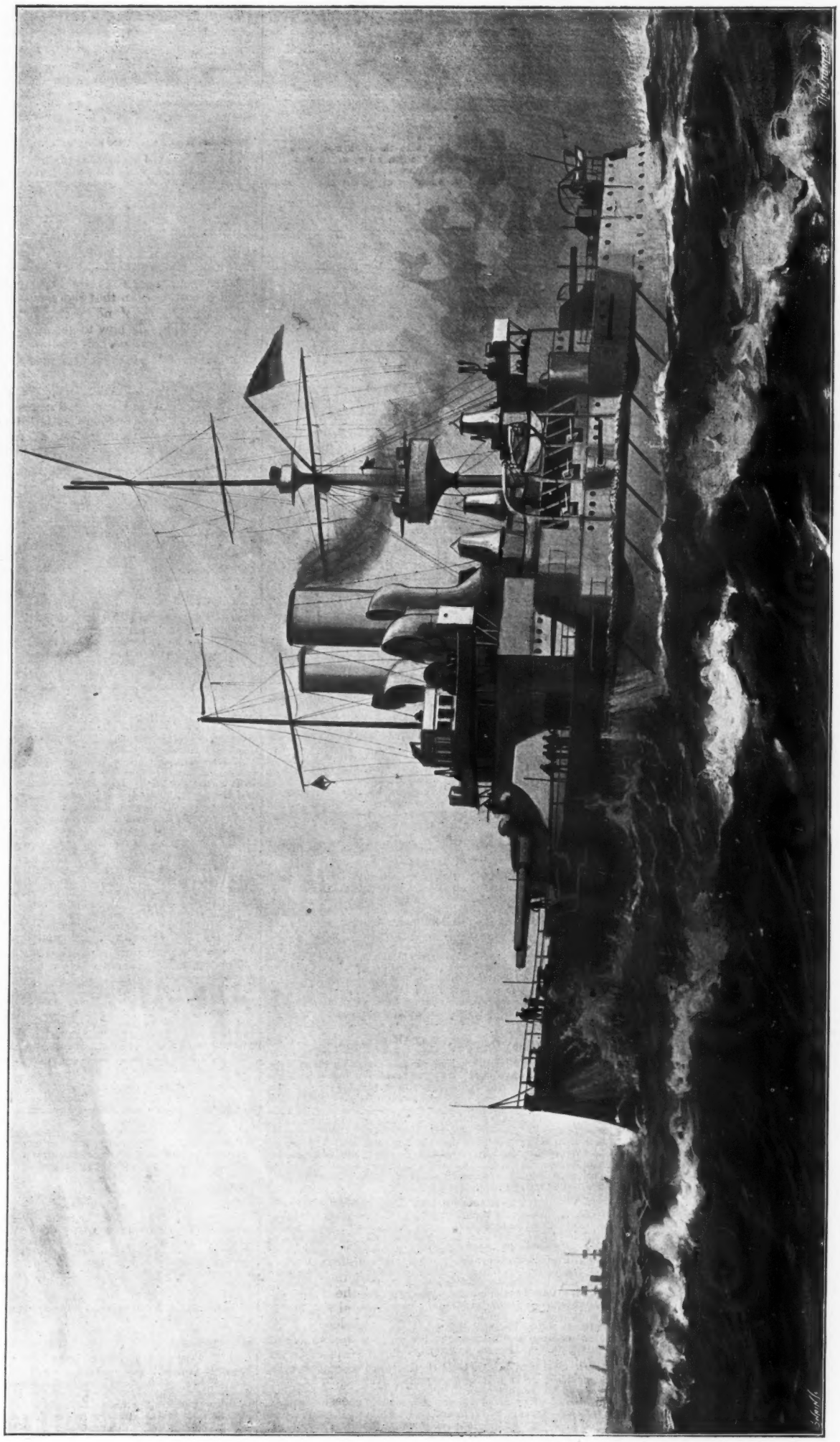
A CONVENIENT system of sending telegrams both inland and foreign by telephoning to the telegraph office either from a subscriber's premises or a telephone call office, exists in Denmark. Any subscriber, giving his number, may telephone his message to the central telegraph station, where it is taken down in writing and telegraphed. No form is filled up and no money passes for the moment, but each subscriber has an account rendered to him in which he is debited with cost of the telegrams, &c., at the end of every month. An extra charge of about a ½d. is made for booking each telegram so despatched.

TWO new reservoirs which will double the storage capacity of the East London Waterworks Company were formally opened on Monday. The reservoirs cover an area of 164¾ acres, and have a total capacity of 1198 million gallons. As soon as the terms of purchase have been settled by arbitration, the directors will hand over to the new London water authority covered reservoirs which have a total capacity of 20,800,000 gallons of filtered water, filter beds with a combined area of 31 acres, twelve storage reservoirs in the Lea Valley, which, when full, have an aggregate water area of 479 acres, a total capacity of 2400 million gallons, and a shore line of over 15 miles; together with the two new reservoirs now added, with a shore line, as reckoned from the top of the containing banks, of more than three miles.

THE Foreign-office has issued a report from the Consul-General at San Francisco, in which he states that a new demand has sprung up for Californian redwood. It has been discovered by the chief engineer of the Niagara Falls Power Company that, under certain conditions, the hardest steel is inferior in resisting power to redwood. It appears that the engineer-in-chief of the Niagara Falls Power Company had recommended that redwood should be employed instead of steel for a great tunnel to be constructed this summer. The reason given for the preference for the California wood was, that when water passed over it continuously, there formed a surface of soapy and pasty nature which was proof against corrosion, whereas in the case of steel the particles of sand and matter carried with great velocity from the Niagara River cut into and destroyed the steel in an incredibly short space of time.

FIRST-CLASS BATTLESHIP CENTURION—RECONSTRUCTED

(For description see page 631)



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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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REPLIES.

T. E. T.—We have not published drawings of G.N. Railway express engine 990, nor of any similar type of engine of this railway.

R. S.—We do not think your invention is of much value. You will find the names of makers of game apparatus in the advertising columns of the *Field* and many other journals.

W. C. H. (Kilburn).—The Spongograph packing is manufactured by Mr. James F. Burnes, of Philadelphia, and we understand that this is a sufficient address for letters to reach him.

S. E. W. (Chester).—Iron and steel are case-hardened by putting them in boxes containing charcoal and keeping them at moderate red heat for a period of six hours to thirty hours, according to the size of the article and the depth to which carbonising is intended to extend. The boxes must be covered and the joints luted with clay to keep out the air. An experienced workman must be employed if you have any considerable variety of parts to deal with. An extremely hard skin can be put on pivots and small spindles by heating them to a red heat and sprinkling them with yellow prussiate of potash.

DEATH.

On the 14th inst., at 45, Onslow-gardens, S.W., EDWARD WOODS, Past-president of the Institution of Civil Engineers, aged eighty-nine.

THE ENGINEER.

JUNE 19, 1903.

THE ENGINEER AND THE PHYSICIST.

WE learn from the James Forrest lecture—with which we have dealt on another page—that the Council of the Institution of Civil Engineers hold that the aid of the physicist should be called in to help engineers to the solution of various problems. They took the first step in this direction when the late Sir William Anderson delivered a Forrest lecture on "The Interdependence of Abstract Science and Engineering." Subsequent lecturers handled the subject historically. Leaving history, the Council proposed to open new ground, and desired that the lecture this year "should be devoted to indicating some of the directions in which the further aid of the physicist is more immediately required by the engineer, while they hope that in future lectures each branch of inquiry thus pointed out will be dealt with in detail by someone who has made that particular subject his special study." The entire scheme thus set forth is full of importance. Unfortunately, for the moment we do not quite know what it means, and we go so far as to say that the Council are not more enlightened than we are. The difficulty of the position is two-fold. In the first place, we do not know what the man of science proposes to do for the engineer; and, in the second place, assuming that he has all the goodwill in the world, we are not certain that he has the power to lend efficient aid.

A proposal so important, emanating from a body so influential, cannot be lightly passed over. The very making of it implies a conviction on the part of the makers that the engineer is not competent to solve various physical problems which, nevertheless, concern him closely. It implies further—and the implication claims careful consideration—that these problems ought to be solved. We are not surprised that Mr. Maw felt very "great hesitation and most serious misgivings in undertaking his portion" of the proposed work. He has sketched various directions in which research is desirable. The paramount, and, we believe, unavoidable defect in his lecture is that it gives no definite indication of the way in which the man of pure science can help the engineer. Now this is really the pivot on which the whole scheme turns. Without disparagement to the engineer, we may admit that he has not the time to carry out recondite inquiries, without prospect of much benefit, as to the operation of what it is the custom to call natural laws, in the field which he cultivates. It may be desirable, and altogether advantageous, to call in the aid of the pure physicist to pursue these inquiries from which much is expected. But it seems to us that before the members of our profession can, as a whole, be got to admit this, it will be necessary to formulate a definite line of action, a precise point of contact between the everyday work of the engineer and that of the college professor—for that is virtually what the whole scheme comes to. Put into simple English, the Council of the Institution of Civil Engineers hold that the professor can and ought to pursue research for the benefit of engineers. To us the scheme means this or it means nothing.

For the moment we may leave civil or statical engineering on one side. There are very few problems left for solution in this direction that would puzzle even for a moment our leading engineers and contractors. The scheme is obviously intended for the benefit of the mechanical or dynamic engineer, the man who deals with things in motion, not things at rest. It is going over very old ground to say that mechanical engineering is pursued by all but a negligible few as a means of making money; and no aid rendered by college professor or any one else will be valued, or will, indeed, be valuable, unless it promotes the making or saving of money. According to some worthy people this is altogether deplorable. Be this as it may, it is quite useless to shirk the fact. The pure scientist can go on his way admired and praised; the engineer claims an equal right to go on his way, making money if he can. But the moment the man of science is called in to help the engineer, he must come down—or climb up—to the engineer's level, and supply just that kind of information that represents money, or else his work will be of no avail. If the physicist can teach the engineer how to get more power than heretofore out of a pound of coal or a pint of oil, well and good. But the result of an inquiry into the precise nature of the chemical changes that take place during combustion possesses neither value nor interest for the steam user, the shipowner, or the engineer, unless it tells him how to reduce the cost of power. In a word, the aid given by the physicist must be mainly utilitarian; if it be not, then the engineer will quietly ignore the professor.

When we regard the scheme from this point of view, we become impressed with the difficulties which must be met in carrying it out. Mechanical engineering is not a new thing. In all civilised countries very able men have worked hard at it. Most of these men have combined very high science with a keen attention to the commercial element. Is it likely, for example, that any pure physicist can really teach the leading engine-building firms how to get more economy? Is there any professor of engineering alive who could tell Leavitt, or Worthington, or Davey how to make better pumping engines than they now build? We naturally turn to Mr. Maw's lecture for a direct or implied answer to the general problem which we have indicated by the preceding questions. But we look in vain. He holds that "research, to satisfy present requirements, must be of a character differing widely from ordinary engine trials," and, as an example, he cites Callendar and Nicolson on the laws of the condensation of steam. But the practical engineer and the owner of sea-going ships cares nothing for any information about the laws of the condensation of steam. What he wants is to be told, not how or why steam is condensed, but how he can reduce the cost of condensing it. If Professor Callendar can tell him how to make two square feet of tube surface do as much work as three feet do now, then, indeed, he will be grateful, and justly so; not else. It is because the Professor does not see this that he so often holds that engineers slight him. The truth is that there is no slight in the whole matter. The two men are out of touch with each other—that is all. There is, moreover, a further difficulty which must be overcome. What, after all, do the words "abstract physical science" mean? We shall not waste time in attempting to find an answer to the question. All we know is that in the end the abstract must be reduced to practice, which simply means that before any desirable new information can be obtained concerning steam or gas engines, for example, steam and gas engines must be placed at the disposal of whoever proposes to carry out the research. Mr. Maw has not missed this point. But the best that he can propose is that use should be made of the engines which are to be found in most engineering colleges. It is a matter of common knowledge that these costly little machines have never yet taught anything that was not already well known, and we suspect that the mere hint that they could learn anything worth knowing in this way would be regarded with incredulity by every leading engine-builder in the country.

The view we take of the whole matter is that which we think will commend itself to engineers in general. It is that research and inquiry and investigation are best carried out by—to avoid eupheuism—men engaged in trade. It is to men who have made engines for sale that the world is really indebted for every improvement from the days of Watt down to those of Parsons. That they can get help in various ways from the pure physicist is quite possible. But in the present day science has extended more widely than some persons are prepared to admit; and because the heads of

eminent firms are not always boasting of what they know, it is assumed that they know nothing. The art of the construction of motive power machines has not died out in this country. We have only to go into any power-house, steamship, or locomotive running shed to see that great advances have been made—are daily being made—by the much-abused manufacturing engineer. On the other hand, we may ask how much of all this is due to research or the labours of technical colleges. Unfortunately the history of research is not reassuring. What useful result, for example, has ensued from the labours of the Steam Jacket Committee of the Institution of Mechanical Engineers?

THE PROPULSION OF WARSHIPS.

NOT long since Admiral Melville delivered an address before the Engineers' Club in Philadelphia on "The Military Importance of Naval Engineering Experiments." In the course of this address we find the following passage: "A few dollars spent in well-directed and conscientious experiments may result in a saving of hundreds of dollars elsewhere." The entire paper is based on this statement as a text. It is intended to set forth the scope and purpose of a naval engineering laboratory to be established at the United States Naval Academy. The paper is very clever, very complete, and very suggestive. It raises, however, many questions which will be—some more, some less—keenly disputed at both sides of the Atlantic. We do not think that Americans will, as a body, endorse Admiral Melville's appreciation of German methods. For the moment it would be indiscreet to say anything about British engineers and naval architects. We venture to think that America can have very little to learn, either in science or enterprise, from Germany. However, this is beside the mark—an involuntary digression indeed. We return to our subject. It is one about which Admiral Melville has a good deal to say. He appears to think that all has not been done that ought to be done in the way of acquiring information about the propulsion of ships of war. We are quite at one with him in this respect. Our views diverge as soon as we attempt to reduce our ideas concerning the means of obtaining information to practice. We have over and over again directed attention to the ignorance that exists regarding the screw propeller. We have pointed out that absolutely no advance has been made since Robert Griffiths gave the world a propeller with a big boss and narrow-tipped, oval blades. No one has ventured to dispute the accuracy of our statements, least of all Admiral Melville. In the paper before us he describes an experimental plant consisting of a small triple-expansion engine turning a shaft on which can be fixed various propellers submerged in a tank of water. This tank is so arranged that the column of water put in motion by the propeller passes down one side of the tank and returns up the other side. From this apparatus Admiral Melville and those who have constructed it expect great things; they can measure thrust and power and torque. They will be certainly disappointed. Experiments of this kind made with the screw propeller are more than misleading—they are treacherous to the last degree; and this simply because they can only tell us what the propeller will or will not do under conditions that are never present at sea.

It is taken for granted that the British Admiralty can command the services of the most advanced mathematicians. The propulsion of ships has engaged the attention of very able men for many years. Large sums have been spent on experimental tanks, and if it could be shown that these tanks really taught the Admiralty anything, no doubt more and more money would be voted for the purpose of carrying on a research the value of which ought to be enormous. Those who are responsible for the design of the propellers of our warships are apparently working as much in the dark as though no experimental tanks existed, or, existing, could not teach. On the 16th of January we showed how great was the gain in speed resulting from a change in the proportions and shape of the screws of H.M.S. Drake. Last week our Portsmouth correspondent told us of a yet more remarkable improvement. The Essex with her original propellers made 23 knots with difficulty; she has made 24·8 knots with her new screws. The gain in the Drake was 24·11 knots as compared with 23 knots. When we bear in mind what it costs to obtain even half a knot additional speed at high velocities, we can form ideas as to what the gain in this case implies. Many years ago H.M. despatch vessel Iris was constructed and fitted with twin screws believed at the time to be the best possible for her. As luck would have it, she failed to attain her calculated speed by about half a knot. Several experiments were made in the way of altering the size and pitch of her screws. The final result was that, to the infinite surprise of all the authorities, the Iris attained a speed of about a knot an hour more than a mathematical investigation of her lines and the proportions of her propellers and the power of her engines had forecast. If this ship had only done what was expected of her on the measured mile, every one would have been satisfied. The late Mr. Froude and all the dockyard people would have congratulated themselves. They would have pointed to the power of mathematical research, and its infinite superiority to rule-of-thumb. The missing half knot started that very kind of rule-of-thumb inquiry which the man of science treats with contumely. We see the result. Much water has passed under London Bridge since the Iris ran her trials, and yet the Admiralty engineers and mathematicians, and the present Mr. Froude, seem to be just as unable to hit upon the right propeller for the modern ship of war as their predecessors were in the days of the Iris.

There are three lessons which may be drawn from the story of the Essex. One is that the mathematician is helpless when dealing with the screw propeller, and that the formulæ which he gives the world for calculating proportions will only apply in any case by chance—they have no real practical value at all. The second lesson is that the mathematician lays down admirable rules, but that the Admiralty ignore these, and either out of prejudice or because they are wholly incompetent, persist in fitting wrong screws to war vessels. The third lesson is that nothing is accurately known about the action of the screw propeller; that all theories of that action are more or less defective, mistaken, or misleading, and that up to the present moment no one has been able to hit on any method of investigation which will really give better results, and enable us to form a true theory of the way in which a propeller uses up the power transmitted to it by the engines. It appears to us that the last lesson most nearly represents the truth. Mathematical formulæ are based on insufficient data. The Admiralty designers do their best, but they do not know what are the proper proportions for a screw propeller. Unavoidable ignorance is at once the explanation of, and the excuse for, faulty practice. Yet, when we have said this, it must not be understood that we regard the excuse as in any way complete. A mistake in design that costs a fast cruiser nearly two knots in speed represents a very serious blunder. It may be that it can be explained away. As matters stand, we have no hesitation in saying that the original propellers of the Essex and the Drake were simply a disgrace to the science of the day. The mathematician who calculated their proportions fell into an error for which there is no excuse. A mistake of half a knot, even a whole knot, is excusable. We strongly suspect that the superintendent engineers of any of our great steamship companies will join with us in saying that a mistake meaning two knots is beyond excuse.

One explanation alone remains. It is that men-of-war have characteristics of under-water construction which place them in a very peculiar category—that, in a word, they are such exceptional machines as a whole that it is quite impossible to predicate with accuracy what kind of propeller will perform best. Each ship being a law to herself, past experience is of little value. The answer to this argument is, however, that no naval architect has said that the laws of liquid resistance, the form of the currents and eddies set up, or the nature of the stream lines, are different in the case of a man-of-war from those proper to other ships; and so we come back to our main contention, which is that while it may very well be that no research carried out with models can supply much information about the theory of screw propellers, yet that there ought to be available at the Admiralty practical data concerning the ratio of screw blade surface to immersed midship section, wetted area, and such like, which would supply sufficient information to suffice for the preparation of designs for propellers which would not waste, as that of the Essex have apparently done, something not far from one-third of the whole power of the engines.

THE INSTITUTION OF GAS ENGINEERS.

THE general character of the proceedings at the annual general meeting of the Institution of Gas Engineers was outlined in THE ENGINEER of the 12th inst., and it only remains to indicate more precisely the scope of the technical communications, and to state that the election of officers for the ensuing year resulted in Mr. H. E. Jones, M. Inst. C.E.—who resigned at the close of last year the position of engineer and general manager of the Commercial Gas Company, which he had held for many years—being selected for the presidential chair of the Institution.

Two papers were read on Tuesday, the 9th inst. One by Mr. S. O. Stephenson described his experiences with the method of introducing water gas into retorts during the carbonisation of the coal at the Tipton gasworks, of which he is manager. He spoke favourably of the method, but his conclusions were severely handled in the course of an interesting discussion to which Messrs. A. G. Glasgow and J. P. Leather were the most noteworthy contributors. The principal fault found with the paper was that the analytical data were quite insufficient to support the broad generalisations of the author. The other paper read on Tuesday was by Mr. W. Grafton and dealt with "Photometry and Testing." It was mainly a criticism of gas testing as conducted by gas examiners in the metropolis, and displayed all the worst fruits of the existing system of penalty testing, which seems to stultify the natural intelligence of gas examiners. It would appear that too prolonged an acquaintance with the routine of gas testing distorts the vision, and prevents the typical gas tester distinguishing between the essential and the non-essential. As a result, papers such as Mr. Grafton's are presented at meetings of gas engineers, and are received more or less seriously. As a fact, the discussion in this instance followed somewhat broader lines than the paper itself.

On Wednesday, the 10th inst., Professor Vivian B. Lewes delivered a lecture, entitled "Candles and Calories." It dealt mainly with the photometry of illuminating gas, and favoured the method which gives the highest illuminating duty from the gas, when consumed in the Argand burner, irrespective of the actual rate of consumption. Gas which has an illuminating value of 14 candles when tested by this method might, the lecturer said, have anything from 11½ to 13 candles when burnt at the rate of 5 cubic feet per hour in the London Argand, according to whether it was a pure coal gas or a diluted gas. In other words, the favoured method levels the qualities of gases, which differ widely according to the older mode of testing, but at the same time shows a close correspondence with the calorific powers of the gases. Incidentally the lecturer stated that he had been able to confirm the statement that an illuminating duty of nearly 20 candles per cubic foot was obtainable from simple or "blue" water gas when burnt under the Welsbach mantle. He had also been able to obtain a light of 150 candle-power by consuming producer gas under a Welsbach mantle at the rate of 30 cubic feet per hour.

On Thursday, the 11th inst., three papers, dealing with high pressure or intensified incandescent gas lighting, were read. Mr. F. D. Marshall, of Copenhagen, described the "Selas" system of intensified lighting, in which air is mixed with the gas through a meter which is geared with the gas meter, so that a mixture in definite proportions is always ensured. Both high and low-pressure burners are applied by this system, and as high an illuminating duty as 44 candles per cubic foot of gas consumed per hour has been realised by it. Mr. A. W. Onslow, the gas engineer at the Royal Arsenal at Woolwich, described the results which he had obtained with several large installations of high-pressure gas lighting. He favoured relatively high gas pressures—up to 44in.—and obtained an illuminating duty of 35 candles per cubic foot of gas consumed. Mr. William Sugg next read a paper treating of the advances which he had made in high-pressure gas lighting. He discussed chiefly the cost of raising the pressure of the gas. He stated that a 1 horse-power gas engine sufficed to give a pressure of 12in. to 14in. for an installation of 100 to 120 high-pressure burners, each affording an illuminating power of 300 to 400 candles.

Mr. H. Valow next read a paper on "Unproductive Capital and its Relation to Renewals," in which he advocated the provision of a fund for the recoupment of capital expended in gasworks plant, which ultimately has to be replaced by plant of more modern construction. The paper was ably discussed by, among others, Mr. R. O. Paterson, engineer of the Cheltenham Gasworks, and Mr. J. Ferguson Bell, who holds a similar position at Derby.

Finally, Mr. J. Ballantyne, of Hamilton, N.B., described a new process for making sulphate of ammonia. It entails working under a continuous vacuum, and is claimed to reduce the expenditure on wages and fuel in sulphate of ammonia manufacture. The paper was a good one, though somewhat inconclusive, and many questions were put to the author before the proceedings terminated.

The excursion, on Friday, the 12th inst., to Eastbourne, proved a very enjoyable close to the year's meeting. The local gasworks were thrown open to the members, and were described by the engineer, Mr. J. Hammond.

The whole of the arrangements for the annual meeting were very ably made by the Secretary of the Institution, Mr. W. T. Dunn, who was for many years secretary to the now defunct "Gas Institute."

NEW IMPERIAL DOCK, LEITH.—Owing to unforeseen difficulties with rock in the substratum, the operation of clearing away the entrance, which is designed to lead direct from the channel into the new Imperial Dock, Leith, has been somewhat retarded, and the engineers report that at the present rate of progress the excavation of the rock by the General Works Construction Company, Limited, will not be completed earlier than six months hence. The new dock, however, into which water was allowed to enter more than six months ago, has since been available to shipping capable of entering it through the lock which connects it with the Albert Dock. In consequence of the discovery of rock, the scheme of timber piling in connection with the foundations for the "dolphins" for use in the working and protection of vessels entering the basin, must be abandoned, and it is proposed to substitute either a wall of concrete or concrete piers in steel caissons with timber facing. For a continuous concrete wall the cost, broadly estimated, would be £18,000 to £20,000, and for four steel caissons with concrete piers and connecting gangways about £22,000. A special committee has been empowered to proceed with the work in either of the two ways, after receiving detailed reports on the whole subject.

EDWARD WOODS.

ON Sunday morning, the 14th instant, died Edward Woods, at his house in Onslow-gardens, London. We believe that few deaths have taken place that will be more generally regretted in the ranks of the profession. Edward Woods was a familiar figure at the meetings in Great George-street. He was very tall, and even advancing years detracted little from his height. He was one of the most unassuming of men. He made no parade of the deeply religious sentiment that contributed not a little to his power of making friends.

Edward Woods was one of the few remaining links in that human chain which binds the engineer of the present day to the infinitely great past. We speak of the work done in the present day, and the most remarkable virtues are attributed to technical education. The fact is forgotten that it is the man after all, and not his education, that achieves great things. It has been said that if George Stephenson had lived in the present day he would have accomplished nothing. We do not believe a word of it. The men who gave the world the railway system were great men, because with very inadequate means they did great things. Edward Woods was little more than twenty-two years old when he was made chief engineer of the Liverpool and Manchester Railway. He was born in 1814, and was therefore in his 89th year at the time of his death.

About the year 1844 Count de Pambour investigated the action of steam in engines with very great care. Strange as it now seems, it was commonly held before his time that the pressure on a piston must be greater than the resistance, or else the engine could not work. Pambour was the first to show that the steam engine was no exception to Newton's third law, and that the average resistance offered by the piston of an engine was always precisely equal to the average pressure in the cylinder. It is, of course, on the operation of this law that the indicator depends for its utility. The complete enunciation of de Pambour's proposition and its consequences will be found in Rankine's "The Steam Engine," page 341. Pambour did not confine his investigations to stationary engines. He extended these to the locomotive, and he carried out a number of experiments on train resistance, in which he received most able assistance from young Woods. Those of our readers who were present at the discussion on "Train Resistance," which followed Mr. Aspinall's paper at the Institution of Civil Engineers, will remember that Edward Woods stood at the council table and read a statement of the work carried out by the French engineer and himself more than sixty years before. How many locomotive engineers, we wonder, realise that the well-known formula for tractive effort

$$E = \frac{d^2 \times S \times P}{D}$$

originated at the time of these resistance experiments with Pambour?

As far back as 1838 Woods contributed a paper on "Locomotive Engines" to the Institution, in it detailing certain changes that had been made in the Rocket class. He said that their weight had actually been brought up to 10 tons. After being a member of the Institution of Civil Engineers for forty years, he was elected President in 1886. In 1840 he married Miss Goodman, of Birmingham, and he leaves two sons and two daughters.

Mr. Woods, as we have said, received no technical education. He never was apprenticed. His father, Mr. Samuel Woods, was a Lombard street merchant. He was educated at two private schools, and it was arranged that he should go as a pupil to Mr. Price, at the Neath Abbey Ironworks, but the plan was not carried out. There was no opening ready for him, and while waiting for one he went to some friends in Liverpool, and through the influence of Mr. Cropper, one of the directors, and of Mr. Henry Booth, the secretary of the Liverpool and Manchester Railway, he was entrusted for four years, at a small salary, with the supervision of that part of the line—some 15 miles—between Liverpool and Newton-le-Willows. Henry Booth, we may say, was the English inventor of the tubular boiler, which was about the same time invented in France by Seguin. Woods served under John Dixon, who had succeeded George Stephenson as chief engineer. Stephenson and Locke left, and were followed by Dixon, in order to make the Grand Junction Railway—Warrington to Birmingham. Thus it happened that, after two years, Mr. Woods got the place vacated by Mr. Dixon. His relations with the railway extended to 1852, a period of eighteen years. One of his principal works was the Victoria Tunnel, two miles long, passing under Liverpool, uniting Edgehill with the docks. This was completed in 1848.

At the close of 1852 Mr. Woods left Liverpool and settled in London as a consulting engineer, and thenceforth entered upon the design and construction of waterworks, gasworks, and railways at home and abroad. His principal operations took place in South America, and there is hardly a line of any importance in that country with which he had not to do. He was associated throughout with Mr. Henry Meiggs and his brother John Meiggs as contractors.

In 1875 Mr. Woods took an active part in carrying out the celebrated Trent brake trials for the Royal Commission on Railway Accidents, which had the Duke of Buckingham as chairman.

To say more would be merely to give a long list of the works with which Mr. Woods, in the course of an exceptionally busy life, had to do. Up to the last he retained all his mental powers, and his death was not due to disease, but to that universal decay which is the concomitant of great age.

The remains of Mr. Woods were interred yesterday afternoon at Chenies, Buckinghamshire. The first part of the service was held at the Church of St. Jude, South Kensington, and was very numerously attended, notably by a large number of members of the Institution of Civil Engineers and well-known friends.

EDWARD WOODS

SWEDISH IRON ORE MINES.

THE reports which have just been circulated from Copenhagen in regard to negotiations proceeding there on behalf of the United States Steel Trust for the acquisition of iron ore mines in South Veranger, Norway, recall the fact that representatives of the same American company are credited with having been active in a similar direction in the sister kingdom some time ago. As the efforts put forth in Sweden did not lead to any practical results, the company has apparently turned to Norway in the hope of being more successful, but it remains to be seen whether this anticipation will be fulfilled. The Americans do not stand alone in their desire for the possession of Scandinavian iron ore mines, seeing that a well-known German bank and a metallurgical company were reported to have designs upon certain Swedish mines a few months ago, the purchase price being placed at from £2,000,000 to £2,250,000. This rumour, which proved to be incorrect, owed its origin to the presence in Stockholm of representatives of the bank and company in connection with the shipment of the first large parcel of iron ore from Narvik to Emden for the well-known Dortmund Union, which has arranged through the former for the supply of iron ore from Sweden for a long period of years. The first cargo of iron ore, which is to be regularly forwarded both from Narvik and Lulea, comprised 7300 tons, and it arrived at Emden at the end of January in one of the vessels belonging to the Hamburg American Steamship Company. Although the delivery of ore under this contract will be of an extensive character, there is no doubt that the Germans, equally as well as the Americans, would endeavour to obtain control of some of the Swedish mines if it was possible to do so. But the Swedish Government stands in the way, and the statutes of the iron ore companies stipulate that shares shall not be transferred to foreigners, whilst even if the latter condition were evaded, an apparently inspired article in a Stockholm newspaper recently suggested that the State would still possess sufficient power to protect its interests against the invasion of foreign capital.

Nevertheless, the fact stands out prominently that every desire exists to develop the important iron ore mines, more particularly those owned by the Luossavara and Kirunavara Company and the Gellivare Company, but the lack of the necessary capital would appear to be one of the reasons which deter these two companies from extending operations on a large scale. Consul Broms, who is the principal shareholder in both concerns, has endeavoured to remedy the matter by a proposed sale of the controlling interest to the Grangesberg-Oxelosund Treffic Company, which in turn has sought to obtain a loan of £1,000,000 from the Government for a period of thirty years for the purpose, among other matters, of developing these iron ore mines. An agreement between the Grangesberg Company and the Government was negotiated which would have given the State a greater measure of control over the mines, and which, whilst not interfering with foreigners who at present hold shares in the companies, would have effectually prevented any other foreigners from participating in them; and it provided further that the companies should be authorised to increase from 1,500,000 to 2,000,000 tons the quantity of iron ore that is now permitted to be exported by them every year. The Government introduced a Bill into the Swedish Parliament to authorise the agreement, but it was rejected in May, and the scheme has therefore not been carried into effect. Since then a provisional arrangement has been made between the Luossavara and the Gellivare companies on the one hand, and the Grangesberg Treffic Company on the other, which provides for the latter obtaining practically the control of the former. The hope has, however, not been abandoned of developing the mines by increasing the exports, and the question is now being considered as to the form and conditions under which a participation of the State in the management and finances of the mines could be rendered possible and acceptable to the majority of the members of the Swedish Parliament.

THE PARIS SEWAGE FARMS.

IN our last issue we summarised the report of the Commission of Inspection upon the sewage farms at Méry-Pierrelaye and Carrières-Triel, when they had something to say about the measures for remedying the inconveniences of sewage distribution, such as the flooding of cellars and the water-logging of land. Another report has now been presented upon the farm at Achères in which the Commission fully confirm what has been said so frequently about the danger of sending too much sewage to these farms. They state that at the time of their visit sewage was being pumped to Achères in such quantities that not only were stagnant pools formed in many places, but the sewage flowed into the open drains and thence into the Seine without being purified. As the result of this state of things the farmers were unable to cultivate the land in the spring, so that there was a double infraction of the law, first by exceeding the legal maximum, and again by preventing the land from being cultivated. The Commission recognise that on account of the permeable character of the soil this is only a temporary inconvenience, but it is nevertheless one which is likely to be repeated every spring unless the quantity of sewage is largely restricted, since at this period of the year the agriculturists have no need of irrigation, especially in the case of potato crops, which are the most remunerative produce on these farms. The situation therefore offers a good deal of difficulty. The quantity of sewage to be disposed of is always approximately the same, and as the law requires that the farms should be cultivated, it is obvious that the amount of sewage sent to them must be limited to the farmers' requirements; otherwise there will be no means of growing crops at all, and those who have rented the farm will evidently have a claim against the Municipal Council. If the distribution of sewage is to do any good at all from an agricultural point of view, it would appear that very little is needed during the time the land is under cultivation, while larger quantities would be required in the dry months of summer. It is obviously quite impossible to regulate the sewage in this way, except by sending the surplus into the Seine, which would be a very poor return for the enormous expenditure upon these farms.

The Commission naturally suggest that the quantity of sewage sent to Achères should be largely reduced, and that the farm should be more thoroughly drained. The area of Achères is 1300 hectares, and during 1902 the quantity of sewage distributed was 79,430,991 cubic metres, or nearly 30,000,000 cubic metres in excess of the legal maximum. It is clear that this state of things cannot continue without waterlogging the soil, and destroying all hopes of turning the land to profitable account. The municipal engineers already see that, despite the vast area devoted to the distribution of sewage, the farms cannot take more than they can absorb, which varies according to the season of the year, and experiments are therefore to be carried out with the bacterial system at Ponceaux in the hope that this will satisfactorily overcome the difficulty of dealing with the surplus sewage.

ON Wednesday last, before the Royal Meteorological Society, a paper was read by Mr. J. Baxendell on "The Dines-Baxendell Anemograph, and the Dial Pattern Non-oscillating Pressure Plate Anemometer." The Dines pressure tube anemometer is now the accepted standard instrument for recording wind movement, but it does not record the direction of the wind. Mr. Baxendell has endeavoured to overcome this drawback, and in this paper he gives a description of the combined velocity and direction anemometer, which he has designed for the Fernly Observatory at Southport. In addition, he has designed a non-oscillating pressure plate for showing on a dial the maximum pressure of the wind. By using a combined "head" or vane for the Dines anemometer, Mr. Baxendell has been able to arrange for the new instrument to record (1) the velocity, (2) the direction, and (3) the maximum pressure of the wind.

MESSRS. YARROW AND COMPANY'S WORKS AT POPLAR

(For description see page 611)

300-TON HYDRAULIC PRESS IN BOILER SHOP

LARGE MOTOR-DRIVEN PLANING MACHINE

THE INSTITUTION OF CIVIL ENGINEERS.

ENGINEERING CONFERENCE, 1903.

(*Continued from page* 620).

SECTION III. (*continued*).

The second paper was read by Mr. H. A. Humphrey on

"INTERNAL COMBUSTION ENGINES FOR DRIVING DYNAMOS."

There are now fifty firms manufacturing large gas engines of 200 horse-power and upwards. Almost all these firms have entered this new branch of engineering during the last five years, and the large gas engines now running have been constructed, with but few exceptions, during the last three and a-half years. Table attached to paper shows the number of gas engines above 200 indicated horse-power made by some of the principal firms. The engines now completed or on order number 498, having an aggregate capacity of 310,865 horse-power; and of these, 390 engines are for dynamos, and give collectively 198,405 indicated horse-power.

The following types of gas engines are now made for driving dynamos, and figures are added showing the number of impulses per revolution and the horse-power up to which each type is constructed.

Single-cylinder single-acting gas engines, although made in large powers (600 horse-power to 700 horse-power) by the John Cockerill Co. of Seraing, and by Messrs. Richardsons, Westgarth and Co. in this country, would not usually be chosen in large units for dynamo driving, except where regularity is not important. It is interesting to note, however, that 100 horse-power gas engine sets of the single-cylinder single-acting type are actually in use at the Embrach Works, driving belt-driven three-phase alternators in parallel, a small additional fly-wheel being placed on the armature of each machine.

		Impulses per revolution.	Usual sizes of engines.	Reference number.
Four stroke cycle single acting	Single cylinder	½	Up to 600	1
	Vis-à-vis	1	„ 600	2
	Double vis-à-vis	2	„ 1200	3
	Twin-cylinder	1	„ 800	4
	Tandem-cylinder	1	„ 1200	5
	Double-tandem	2	„ 2500	6
	Vertical two, three, and four-cylinder	1, 1½, 2	„ 1000	7
Four-stroke cycle double-acting	Single-cylinder	1	„ 1000	8
	Twin-cylinder	2	„ 1000	9
	Tandem-cylinder	2	„ 2000	10
	Double-tandem	4	„ 4000	11
	Vertical two-cylinder	2	„ 2000	12
Two-stroke cycle single-acting	Oechelhauser, one-cylinder	1	„ 1000	13
	Oechelhauser, two „	2	„ 2000	14
Two-stroke cycle double-acting	Körting, one-cylinder	2	„ 2000	15

One of the first types to gain prominence was the vis-à-vis engine, manufactured by Messrs. Crossley Brothers, who make engines of 500 horse-power and 600 horse-power with two cylinders, and the Gasmotoren-Fabrik Deutz, who have carried this type up to 1200 horse-power, using four cylinders. Probably no more engines of this type will be made on the Continent, as the Deutz firm have abandoned the design in favour of double-acting single and tandem-cylinder engines. Consequently, although this vis-à-vis type has done excellent service, and is now in use for driving alternators in parallel on a large scale, little need be said about it in face of the change to the double-acting type which is taking place.

Type No. 4 is being made by Körting Brothers, of Hanover, who get about 300 horse-power to 400 horse-power out of each cylinder, the two cranks being placed at 180 deg. This type is going to be largely adopted, but the tandem-engine—type No. 5—with its straight-line stresses and equally-timed impulses is likely to live longer than the vis-à-vis type or the twin-cylinder type. The Premier engine is an example of the straight-line type, and the Premier Gas Engine Company have held a front place among the pioneers in large gas engines. The Nürnberg Company and the Cockerill Company also make very powerful engines of the ordinary tandem type, suitable for direct coupling to both direct-current dynamos and alternators. The double-tandem engine—type No. 6—can be carried to very large powers, and makes a simple and strong engine, but it is heavy for its work and covers a large floor space. Very good work has, however, been obtained from this engine, and it is suitable for driving alternators in parallel up to units of 2500 horse-power.

Quite a number of firms now manufacture vertical gas engines with two, three, or four cylinders (type No. 7), all of them constructed specially for dynamo driving. The Westinghouse Company is the best known maker in connection with this type of engine, but Messrs. Tangyes, Limited, and Messrs. the Campbell Gas Engine Company now construct vertical engines up to 300 and 400 horse-power. The last-mentioned company make a four-cylinder vertical engine which is extremely well balanced, and, as it gives two impulses per revolution, provides great regularity of turning moment. Messrs. Fielding and Platt have made their first four-cylinder vertical engine, enclosed type, and expect a number of orders for engines of 100 to 200 horse-power.

Many attempts were made to get over the difficulty of a piston-rod stuffing-box, and Messrs. Dick, Kerr and Co. years ago constructed and ran at Belfast engines with double-acting pistons and piston-rod glands. The solution of the problem has, however, come gradually, and the Cockerill Company, followed by numerous other makers, have now examples of efficient stuffing-boxes fitted in the closed ends of gas engine cylinders and giving no trouble. Once this difficulty is removed, the gas engine must logically be manufactured as a double-acting machine, for by simply duplicating the valve gear twice the power and twice the number of impulses are obtained from the same size of cylinder without increasing any of the working stresses. So completely has this fact been recognised that all the leading makers now construct double-acting engines—types 8 to 12—and powers of 1000 horse-power with single-cylinder engines, and of 4000 horse-power with double-tandem engines, of the double-acting type, are readily obtainable. Nearly all the important orders which are now being placed for large gas engines are for the double-acting type, and all the types Nos. 8 to 12 give thoroughly efficient prime movers for central station work. In fact, the tandem-cylinder engine—type No. 10—and the vertical two-cylinder engine—type No. 12—are among the chief favourites on the Continent and in this country. The Nürnberg Company and the Deutz Company build double-acting tandem engines which leave very little to be desired in the way of simplicity, smooth running, and good turning-moment qualities.

The Nürnberg engine has the whole of the weight of the piston and piston-rods carried on slides running on guides, so that the piston and stuffing-box friction is reduced to that due simply to the rubbing contact on the piston rings and the packing in the glands. The front slide constitutes the ordinary crosshead, and the back slide-block is utilised to introduce and discharge the water required for cooling the piston and piston-rod. This type of engine has so far reached the lowest consumption of both gas and oil for a given output of power.

The new type of Westinghouse gas engine now being made in this country for powers of 500 horse-power to 2000 horse-power has much the appearance of the vertical Corliss engine so largely used in the United States. The two double-acting Otto-cycle cylinders are carried on A-frames, and the connecting-rods are coupled to overhanging crank pins at either end of the shaft, so that only two large bearings are required. Between these bearings the alternator and fly-wheel are placed, and the whole forms a very compact and powerful set, occupying the minimum floor space, and running at speeds closely corresponding to the usual speeds of similar size steam units used to drive large alternators.

The Oechelhäuser engines have been largely built for dynamo driving by the Deutsche Kraftgas Gesellschaft, and one of their finest examples is to be found in the central power station at Ilsede Hütte, where electric power is developed by gas engines coupled to alternators and supplying three-phase current at 10,000 volts to rolling mills at Peine, about five miles away. The gas engine sets are in 1000 horse-power units, and run in parallel with steam-driven alternators, but the latter are to be superseded when the full 6000 horse-power of gas engines—*i.e.*, six units—is installed.

Last, but not least, we have the Körting gas engine, which heads the list with the highest aggregate of power of any type. It is the only engine at present on the market which gives two impulses in one cylinder per revolution, being in this respect like an ordinary steam engine. Many firms have taken out licences to build this engine, and in this country it is made by Messrs. Mather and Platt, who have just supplied their first 700 horse-power engine for dynamo driving, and by Messrs. Fraser and Chalmers. Full descriptions of the Körting and Oechelhauser engines have appeared in the technical journals, and these types are now almost as well known as the Otto-cycle engines.

Brief mention must be made of the Vogt gas engine, which, like the Körting engine, gives two impulses per revolution in one cylinder. It is unique, in that the explosions take place over water, and the motor cylinder is filled with this fluid. The combustion chambers are above the cylinder level, and the water rises and falls in these as the piston reciprocates. This engine embodies the principle of internal cooling, so that water-jackets are dispensed with and the metal cylinder may be made as thick as strength requires for any size of cylinder. No hot gases come in contact with any moving part of the engine except the valves. Probably a good deal will be heard of this engine in the future, as the results obtained with an experimental engine of small size are excellent.

In the author's opinion sufficient attention has not been given to the construction of gas engines intended to take a supply of both gas and air, separately stored under pressure. For central stations of large size the previous compression of the gas and air, so that they may be drawn as required from reservoirs, has much to recommend it, and involves, with proper precautions, no special danger. The advantage of the two-cycle gas engine would then be attained without the complication of each engine carrying its compressing plant, together with all the extra valves and gear required. Also, there is no reason why the heavy and somewhat noisy cam gear on gas engines should not be replaced and the valves operated by compressed air, or even high-pressure burnt gases stored from the motor cylinder itself, controlled by a small rotating valve.

The term "internal-combustion engines" embraces oil engines, but oil engines above 200 horse-power are rare, and cannot compete in cost of fuel with gas engines using cheap producer gas, especially when the system of recovering the ammonia from the coal—as in the Mond producer plant—is available. The Diesel oil engine has attained a high degree of economy, and has been applied to dynamo driving up to 200 horse-power units.

In general, a gas engine giving at least one impulse per revolution is necessary for all central-station direct-coupled dynamo sets; and in cases of alternators working in parallel, engines should be chosen which give two impulses per revolution. The exact solution of the alternator-in-parallel problem is too complicated, owing to the interaction of the sets, to be given here, but some idea of the relative value of different types of engines for this class of work can be gathered from the Klönne diagrams, which take no account of this interaction. In each case three curves are drawn:—(*a*) The turning-moment curve corrected for inertia of reciprocating parts; the straight line representing the mean work or resistance is made with the same ordinate in all cases. (*b*) The corresponding angular-velocity curve. (*c*) The corresponding angular-deviation curve, showing at any moment the angular difference between the position occupied by the fly-wheel and the position it would have occupied had the rotation been absolutely uniform.

The moment of inertia of the rotating parts, the weight of the reciprocating masses per square inch of piston area, and the ratio of connecting-rod to crank length is assumed to be the same for all five cases.

Using these diagrams it was found that for a 500 horse-power engine—700 horse-power maximum—running at 125 revolutions per minute, coupled to an alternator having a periodicity of fifty cycles per second, the ratio of the moments of inertia required to restrain the angular deviation to ± 3 deg. in all six cases was:—

1	cylinder 4-stroke cycle	.. ..	37·5
2	„ „ „	vis-à-vis	23·1
2	„ „ „	tandem	10·2
4	„ „ „	.. ..	1·0
1	„ Oechelhauser	.. ..	11·6
2	„ „ „	.. ..	1·0

These are theoretical results, and cannot be directly applied in practice; still they convey to the mind an approximate idea of the relative merits of the different types.

The large central electric stations of the future will employ producer gas and gas engines, and several existing stations with steam plant are to have gas engines for additional power, with the ultimate object of the entire replacement of all steam plant.

Professor A. B. W. Kennedy, the Chairman, in declaring the discussion open, pointed out that he was very far from convinced of the reliability of gas engines as the prime mover of the future, in spite of the fact that he designed the first gas-driven electric generating station.

Mr. Crossley could not understand why the author should predict the extinction of the vis-à-vis engine. If they went in for tandem engines with a piston in a closed cylinder, they must have a watered piston, even with sizes smaller than a 20in. cylinder. Watering was a considerable nuisance and a great danger, and it was terrible to think what might follow the stoppage of the circulating water. To make a 6in. piston fit a cylinder properly when it was hot, there had to be a clearance of $\frac{1}{8}$in. when it was cold. A watered piston must be a good fit, and therefore, if the water was withdrawn for any reason, the piston would expand in a very short time the $\frac{1}{8}$in. Further, with pistons cooled by water coming through an expansion chamber, a good deal of power was lost there. In the Körting engine there was a loss of 9 per cent. at the piston-rod end, and the Griffin gas engine, described some years ago before the Society of Arts, showed a loss of 16 per cent. at the piston-rod end. If one was bound to go in for watered pistons, it was as well to have closed cylinders. He did not think, up to a certain size engine, that motion beams were necessary. They were an extra complication.

Mr. Michael Longridge complained of the difficulty of obtaining high-power gas engines, and that experience of these seemed to be absolutely non-existent. In Germany there were a number working with weak blast furnace gases, which, however, introduced a greater difficulty of keeping the engine together than ordinary producer or town gas.

Mr. Mark Robinson asked a number of questions. First of all, what was the value of the various cycles described in the paper from the point of view of reliability of running, having in view the possible danger of pre-ignitions through over-heating. Obviously, he said, the two-cycle engine was very much better than the four-cycle engine. It ought to be possible to get twice as much power from a given sized cylinder and a given sized crank, other things being equal. But were these other things really equal? For instance, in order to work as safely with a two-cycle engine, must a scavenger be introduced, or could it be done without in a four-cycle engine?

Dr. Edward Hopkinson, comparing the cost of fuel in gas engine and steam engine-driven electricity works, said that with the latter about 2½ lb. of coal per kilowatt hour were consumed, but that a similar figure for the gas engine was not available, although he put it at 2 lb. Quite an insignificant difference, he said, but when all the other factors were taken into account in making up the total cost of the energy derived from the two sources, in such a place as an electric generating station, where the average load factor was not more than 25 per cent., the consumption of coal by steam driving was on an average of a large number of stations 8 lb. per kilowatt. Obviously it would be less with gas, and he put it at 3 lb. These figures did not take into account the recovery of ammonia from the gas. At present there were 80,000 horse-power of large Körting gas engines on order, and he rather fancied that the author's calculation of the total horse-power on order was under-estimated. Experience was still very much to be gained with regard to large gas engines, but it was already tending towards the use of the double-acting single cylinder. The difficulty of the piston-rod passing through the front end of the cylinder had now quite disappeared. This was a matter closely bound up with the water-cooled piston. Water-cooling was absolutely necessary if the piston rod passed through a gland in the front end of the cylinder. The Körting engine was now made up to 2000 horse-power, and not 1000 horse-power, as given in the paper.

Mr. Davey said it appeared to him that the most important thing necessary was a satisfactory producer. The discussion of this appeared to have been overlooked, but if a little more attention was paid to this matter it was quite possible that the general application of the gas engine would be brought a step nearer.

Major-General Webber spoke of his connection with the Belfast gas-driven electric lighting station and other pioneer work. He agreed with Mr. Davey that a satisfactory producer was necessary. Central station engineers wanted a producer which did its work, and only its work, without giving worries with by-products. He also referred to the fact that the Mond Gas Company contemplated distributing gas from large centres in North Wales at $\frac{3}{8}$d. per 1000 cubic feet. If this were to be accomplished, then Dr. Hopkinson's figures of 3 lb. and 8 lb. would be achieved. At present, however, he could not see his way to saying that the use of gas for generating electricity would become general for sometime to come, until a more satisfactory producer had been evolved.

Professor H. R. Burstall dealt with the question of running alternators in parallel. The real difficulty at present was to find out what deviation from synchronism electrical engineers would put up with. For three months he had been unable to arrive at any definite conclusion in this matter, owing to the fact that no satisfactory answer had been vouchsafed by the electrical engineers. One had said a deviation of 1 in 350, and another 1 in 700. But could not electrical engineers construct dynamos which would not get out of parallel even when the deviation exceeded this amount? He had made a number of suggestions to electrical men, but, coming from a mechanical man, his ideas had not been taken up. He had got out dimensions for a 1000 kilowatt alternator which had a 50 ton fly-wheel, 18ft. in diameter, a 1 in 150 deviation, and 50 revolutions per minute, to be direct connected to a four-cylinder single-acting engine. It was a rather heavy fly-wheel, he admitted. In conclusion, if the dynamo makers could see their way to putting up with a small cyclical variation, the practicability of the gas engine for central station work would be much more favourable.

Mr. Charles Hopkinson, referring to parallel running, said the variation of speed was the product of the inertia and the turning moment, the former being the really important factor. Steam-driven alternators running well in parallel would run in parallel equally well in connection with gas engines with a much less uniform turning moment, but alternators which were not running well in parallel with steam engines, would not run in parallel if coupled to turbines. He had gone into the matter rather fully lately in an investigation of the local currents in the field of an alternator, and the variation of the currents of the field coils and *ammortiseurs*, as they were now called, to discover the effect on hunting. He held that hunting was very largely governed by all these. If there were two alternators driven by turbines with absolutely even turning moment, and one was retarded, and allowed to run on again, it would be found that that one would oscillate about the position of steady motion, sometimes running ahead and sometimes getting behind, with a perfectly definite period dependent only on the inertia of the machine, and on its electrical properties. The damping effect of all the local currents mentioned was dependent, also, very largely on the period of that oscillation, and the amount of damping increased very largely with the period, *i.e.*, the slower the oscillations the greater the damping. The period of the oscillation was very largely influenced, also, by the fly-wheel effect

of the machine. Probably, it would be found that when we came to specify alternators for driving with gas engines, the inertia of the dynamo and fly-wheel, considered as a whole, would have to be taken into account, and not the variation of speed in the revolution. The fly-wheel would have to be considered as a part of the dynamo, and not the engine.

Mr. L. B. Atkinson suggested the use of non-synchronous, or induction alternators, as the means of obviating the difficulties of parallel running. These had been adopted on a very large scale in connection with water and steam plants.

Mr. W. H. Booth pointed out that a large proportion of the gas engines mentioned by Mr. Humphrey were of foreign origin, and that, had it not been for the use of blast furnace gas, such great progress would not have been made on the Continent. He asked what proportion of the 381,000 horse-power mentioned in the paper related to engines using blast furnace gas, and how much for ordinary producer gas. Blast furnace gas was more free from hydrogen than other gases; it did not explode prematurely to the extent which other gases did, and the degree of compression was much higher.

Mr. A. J. Lawson referred to the high efficiency of the Diesel oil engine.

Dr. A. B. W. Kennedy asked Dr. Hopkinson the relation between the 8 lb. of coal consumption for steam driving and the 2½ lb. for gas driving which he had mentioned. He had never yet come across an electric generating station which did so badly as 8 lb. per kilowatt hour. The average best eight-hour shift was about 3½ lb., and the average, week in and week out, about 5½ lb., non-condensing.

Dr. Hopkinson replied that his figure for steam driving was an actual average for a large number of electrical stations. Possibly there were a number doing a little better. His figure for gas driving was 3 lb., and not 2½ lb.

Mr. Campbell, taking up the remarks as to the want of a satisfactory producer, said that these could be obtained for working with ordinary coal, coke, or anthracite, and they could also be obtained without ammonia recovery. He did not think English gas engine makers had been given the opportunities which continental firms had of showing what they could do, hence the greater development abroad. As to the parallel driving of three-phase alternators with belts mentioned by Mr. Humphrey, he said there need be no difficulty with these. The trouble arose when direct coupling was employed. He had his engines in Spain direct driving such alternators. On the fly-wheels was a magnetic brake, and the overplus of current was used to retard the engine, and so enable it to keep step with the other. His firm also supplied a gas engine with one impulse every two revolutions.

The Hon. C. A. Parsons disagreed with Dr. Hopkinson's figures, and said that for a thorough discussion of the matter further details were required as to the cost of running, and the capital expenditure and reliability.

Mr. Humphrey, in reply, did not deal with any of Mr. Robinson's queries owing to the shortness of the time at his disposal. He said he knew of a comparison between steam and gas driving, both in the same works—an electrolytic works—in which the cost of fuel for the former was almost exactly double the latter—viz., ·14d. per unit for the gas and ·268d. for steam. Major-General Webber was wrong in his assumption that gas was to be supplied by the Mond Company for ⅜d. It would be something like 2d. on an average. As to cyclical variations, a prominent American engineer had told him that 1 in 400 was quite good enough. If it was not, gas-engine makers were prepared to make something better. Dealing with Mr. Booth's statements as regards the quality of blast furnace gases, he said that ordinary mine gas contained 29 per cent. of hydrogen, and lighting gas 50 per cent. of hydrogen. His experience had been that compression pressures of 120 had been obtained without any trouble; with ordinary gases no one had yet proved to him that lighting gas would not ignite where producer gas would.

A vote of thanks concluded the discussion.

The last paper read was by Mr. H. J. Marshall on

"Gauges and Standards as Affecting Shop and Manufacturing Administration."

In dealing with this subject, which is a very wide and far-reaching one, the author has endeavoured to outline briefly the effect which he personally has found to be the result of the use of gauges and standards as a means to improve the quality and to cheapen the cost of work produced. The methods described are in no way regarded as satisfying or final, but only as first steps to the introduction into an old-established factory of systematic methods of manufacture: this is necessarily a work of time, and also of considerable labour, yet the results to be obtained will, it is believed, amply compensate for the time expended. An apology must be made for the frequent recurrence of the words "detail" or "unit," which are used to designate an elementary part, the production of which is considered without reference to its relation to any other part.

Manufacturing in detail.—To produce cheaply and accurately it is absolutely necessary to consider the production of every individual unit, entirely without reference to any part with which it must fit. To any one producing large quantities of some simple article of general use this is an easy matter, but to anyone covering a large range of manufacture a beginning must be made by standardisation of detail, *i.e.*, parts approximating in type must be tabulated throughout all articles to be manufactured. Parts must be put through in quantities, as opposed to the old practice of putting work through in sets, *i.e.*, in groups of parts which go together to form a whole; by this method only is it possible to obtain the fullest advantage from the use of gauges and standards.

The old way.—The object of putting work through in sets or groups of parts was twofold:—(1) To ensure all parts fitting into each other correctly. (2) To ensure units being put through in correct numbers to form complete sets.

The new way.—Under the system to be described, these requirements are met by:—(1) Limit or other gauges to give accuracy of fit and to ensure interchangeability. (2) To ensure complete sets being stocked, a system of storage is introduced which gives for each unit a maximum number to be stocked, such numbers being fixed to keep stock of parts in correct proportion.

General results of the use of gauges and standards.—The use of gauges and standards is an absolute necessity to the system, in order to secure the following results:—(i.) Uniformity and accuracy of workmanship, which are necessary to interchangeability. (ii.) The cheapening of production by specialisation of plant for individual operations. (iii.) The cheapening of production resulting from the application of routine methods to the production and storage of individual parts or details.

(i.) *Use of gauges and standards as influencing uniformity and accuracy of workmanship which are necessary to interchangeability.*—This may be briefly divided into:—(i.*a*) The limiting of travel of cutting tools by the use of stops or micrometer adjustments in a lathe or other tool, or by fixed points on templates or gauges in planing, slotting, or milling machines, in order to give without measurement the diameter of work or location of plane surface, which must correspond with the diameter or plane surface of work produced in quantities on other tools. This enables the manufacturer to produce separately, and yet with accuracy, articles, say, with flanges which must couple together, or plane surfaces which must come together at fixed distances from certain points. (i.*b*) The use of limit gauges to ensure the correct fit of any two units which come together in the formation of a fitted article. By the use of limit gauges, details or units can be produced in special tools separately and correctly without reference to any other part. In considering limit-gauge work, it is in most cases advisable to have one fixed limit for holes, and to vary the limit, to suit fit required, for parts fitting the holes. Limits allowed must vary to suit requirements of different manufacturers. For work approximately to 6in. diameter, the following limits have been found by the author to give satisfactory results as far as they have been used, but as yet they have only been tried in certain sections of work:—

For holes ..	− 0·0005 go in,	+ 0·001	not go in, or a mean of	+ 2/1000
Force fits ..	+ 0·006 go on,	+ 0·004	not go on, " " "	+ 1/1000
Driving fits ..	+ 0·0015 "	+ 0·0005	" " " " "	+ 1/1000
Sliding fits ..	− 0·0005 "	− 0·0015	" " " " "	− 1/1000
Running fits	− 0·0015 "	− 0·0025	" " " " "	− 1/1000
Loose fits ..	− 0·004 "	− 0·006	" " " " "	− 1/1000

(ii.) *Influence of use of gauges and standards on specialisation of plant for individual operations.*—This might be classified briefly as follows:—(ii.*a*) Standardisation of operation.—Where individual parts or details cannot be assimilated, it is advisable to consider single similar operations on a number of different parts; for instance, a flange-facing operation as a first operation to be performed on a specially designed tool, preparatory to dealing with the more complicated operations on the same part on more suitable tools, or the production of threaded spindles of all sorts by—(1) rough turning, (2) grinding, (3) threading on a special tool.

(ii.*b*) Standardisation of detail.—This is the most important point for consideration in manufacture, and cannot be thoroughly carried out except by the help of gauges. Standardisation throughout manufacture facilitates close attention to the best and cheapest carrying through of every operation, in the case of a casting, from the best form of pattern to meet the requirements of the foundry to the best form of casting for the application of special tools to each operation. No single operation on which time can be saved is too trivial for the fullest consideration of specialisation in methods and plant; the time so expended must be looked upon as first cost to effect a daily saving. Here might be mentioned the consideration of saving in time occupied in setting, in which there is often as much margin for time-saving as in the actual time taken in cutting. Standards facilitate the use of special chucks and fixtures in which a casting or forging is readily set by locating points, and clamped quickly by means of excentric clamps, knurled headed screws, or other similar means. Drilling, too, on circular or rectangular surfaces, should, where possible, be standardised, and drill jigs should be used as a means to accurate reproduction.

(iii.) *Influence of the use of gauges and standards on the application of routine method to the production and storage of individual parts or details.*—A system of storage is introduced by means of which each individual part or detail has a symbol for type, and a number for size, a maximum and minimum stock being fixed. A stock card is kept in a slide in each partition in the stores, incomings and outgoings being entered on the card, and an order issued when the minimum is reached; in this way stock of parts is automatically kept at its right level.

Captain Sankey said the arrangements described in the paper were excellent for what he might call a first approximation, but modifications would have to be introduced after a little experience. Parts did not get arranged in proportionate numbers, as had been assumed. No account had been taken of changes which must take place. Then, in the system described, there were no less than six different kinds of limiting gauges for each dimension from 1/16in. up to 6in. There would therefore be thirty different dimensions to be dealt with, or 180 gauges. With large gauges up to 4ft. diameter and down to 1/16in., spoken of, the amount of capital involved in them would be so enormous that very few manufacturers would be able to face the expense. He was against the use of limit gauges for large sizes. The limit gauge was practically confined to work where the units were of less value than the time of some higher authority than inspectors.

Mr. W. H. Allen emphasised the value of the paper, and as he was working upon the system described he could not criticise it. With regard to changes mentioned by Captain Sankey, these only took place periodically, and therefore the limit gauges gave a great value in this respect. Limit gauges had not yet been considered for large sizes, and from 4ft. downwards such small increments as 1/16in. would not be utilised. He did not think it would be possible to get along without the limit gauge.

Mr. Matthews said that one of the greatest engineers, Mr. John Penn, at the time of the Crimean War, had gone in for a limit gauge system. But since then he system inaugurated by him had slid away. But everything could be killed by expense, and if the cost of gauges was going to be more than the work could stand, then it was a bad thing. But there was no doubt as to its advantage where there was multiplicity. Everybody should start with a standard, and keep it as their own, and not let it be everyone else's standard. This had been one of the great curses of the Whitworth thread, and the thing had got a bad name when it did not deserve it. At the National Physical Laboratory no doubt Dr. Glazebrook would be able to help them. There was a certain class of trade—a rough class—which had to come into competition with German and American goods. These trades could not stand the expense.

Mr. Crossley said he had been using the limit gauges at Openshaw for a considerable time. If everyone went in for stocking goods by limit gauge, and also went in for improvements, the scrap heap would have to be a large one.

Lieut.-Colonel Crompton said that limit gauges presupposed error to a certain extent. But the accumulative error might be so considerable that there was a point at which there would have to be a self-centering device, and not depending on limits. With regard to what Captain Sankey had said, the main object of having a limit was that it was then possible to do away with a large and highly paid inspector staff. This he personally agreed with. This was the whole object of the introduction of limit gauges.

Mr. Mark Robinson thought that a misunderstanding had arisen. The question of expense did not mean that gauges should not be used for any particular work because they were expensive. There were numerous cases in which it would not be advisable to use limit gauges, in the strict meaning of the term; but they were specially applicable for any kind of repetition work. A standard gauge had the advantage that it was much more easy to measure the difference between the gauge and the piece of work than when a double-gauge was used. As to viewing, the fact was that there should be two viewing departments—one, the works manager's viewer, who might apply any kind of gauge, and even prevent the work coming out of the shop; and, two, the more severe viewing afterwards.

Mr. Davey advocated the use of standard gauges where necessary, at the discretion of the manufacturer.

Professor Barr considered the viewing department as of great importance. In a manufacturing department which was manufacturing a number of articles to a standard size, and where the "premium" system was introduced, such a viewing department should form part of the training. Captain Sankey was quite wrong as regards limit gauges for large sizes, as there were no works in which a variety of large sizes were adopted. For anything over 2ft. there would only be one or two sizes required. He also mentioned that there was a difference in this connection between work that was being done for stock and that which was being done for contracts. He emphasised the remarks of the author in connection with symbols. He had adopted such a system in his work of both parts and operations, and had found it saved a great deal of time.

Mr. Thomas Parker advocated the use of limit gauges.

Mr. Sharpe mentioned a system of selection which is in vogue at the works of Messrs. Hans Renold. In the sleeve of a chain, for instance, which had three principal measurements, three selections were employed, and an accuracy of 1/1000in. was obtained. Cheaper production also resulted.

Mr. W. H. Maw remarked that a very important question was that of standardising similar details, not necessarily for the same class of machine. The author of the paper had spent a great deal of time upon this matter, and had had the system at work for many years. Such things as shaft collars, for instance, varied but a fraction for a large variety of machinery. This prevented the stocking of a large number of different-sized collars. But this was a work which required a very great deal of care, and a strong man to introduce it into a factory which produced different articles.

Mr. Crossley said he had worked upon such a system for some time. He had sheets in the drawing-office for collars, pins, rollers, cams, and all such parts, and if a man was getting out an engine it was his duty to put No. so-and-so collar, &c.

Mr. Campbell said the same system was followed by himself.

Captain Sankey remarked that Messrs. Willans and Robinson had also adopted the system mentioned by Mr. Maw.

Mr. Maw pointed out that Mr. Marshall did not apply the system merely to one type of machine, but to all kinds of apparatus, and his chief difficulty had been to get the various departments to work together.

Mr. Whitfield said that it was not generally known that the Board of Trade was in possession of a set of standard gauges, such as had been mentioned in the paper.

Mr. Marshall being absent could not reply, and a hearty vote of thanks closed the discussion.

SECTION IV.

In Section IV.—"Mining and Metallurgy"—four papers were read, abstracts from which we give below. The first was by Sir Thomas Wrightson and Mr. John Morison on

"Percussive Coal Cutters."

Careful examination of the position in respect of coal cutting in this country and in America leads, in the authors' opinion, to the following conclusions:—(*a*) That in America machine coal cutting has been successful both in respect of the relative cost of hand to machine work, and in respect of the universal adoption of machines. (*b*) That in this country, in both respects, up to the present time almost the opposite experience has been the result of the adoption of machinery, it being found that the generally expressed opinion is that the economy, except in special cases, is doubtful, whilst the use of machines is extending very slowly, and their general adaptability is very far from being recognised. Looking more closely into the causes of this apparently anomalous position, it is the authors' opinion that they may be traced to the following:—(1) To the more favourable general conditions of the American coal seams in respect of thickness, depth, and inclination. (2) To the softer nature of the American seams. (3) To the fact of the two conditions above stated lending themselves to the easy application of machinery of the type of the American percussive or punching machine, and other machines which do not require a long wall face or any other special conditions in working, but which are adapted to the ordinary system of working prevailing in a mine.

The conditions in this country differ in respect of the hardness of the coal and the thickness generally of the seams; but the prevailing feature which, in the authors' opinion, has been the cause of the failure of percussive machines in this country and their success in America, is the harder nature of the coal seams here.

Percussive machines of the American type have been over and over again tried in this country and abandoned, and, at the present time, if any are working successfully, it is not generally known, and is nowhere, to the authors' knowledge, recorded. In America, on the contrary, the prevailing machine, and the machine which at the present time is mining most coal, is the percussive machine. Thousands of these are in use daily, and apparently they are worked without any great difficulty in their manipulation. The percussive machine, as used in America, may be described as follows; and it may be explained that, while there are several makes machines, all are of one type, and are worked on a similar

principle. The machines are constructed with the following main parts:—(*a*) A cylinder of 3in. to 4in. bore and 9in. to 12in. stroke. (*b*) A piston and rod, with the rod extended to take the tool. (*c*) A valve and valve chest, the valve being thrown by air, or operated by a small independent engine, cushioning arrangements being in all cases a necessity. (*d*) A sleeve or guide attached to the front end of the cylinder, to guide and steady the piston-rod, and extended for a considerable length for the purpose, and also provided with arrangements for preventing the piston and tool from turning. (*e*) A suitable pick or tool usually sharpened to a fish-tail shape. (*f*) A pair of plain wheels upon which the machine is carried, the wheels being placed so as to balance the machine. (*g*) A pair of handles at the back. (*h*) A long board, 7ft. to 9ft. in length by 2ft. in width, and raised at one end to form an incline.

The following is the method of operation:—The machine is wheeled up to the face of the coal, and placed upon the inclined board, and the operator seats himself upon the higher or back end of the board, places one foot behind the wheel as a chock, and guides the blows of the tool by moving the machine on the board, as required, by means of the handles. As the coal is cut an assistant shovels it out, and, when the "kirving" or under-cutting is effected within the range of the position of the board, the latter is shifted and the proceedings are repeated.

The incline of the board and the chock provided by the operator's foot take up to some extent the recoil of the machine, but the work is undoubtedly severe, especially in the case of an unskilled operator, and if the coal is so hard as to require prolonged use of the machine before the requisite extent of cutting is effected, and the operator cannot rest frequently, it becomes unendurable, and in a hard coal the requisite speed of cutting is not obtained, and the machine becomes uneconomical.

It appears to the authors that, in order to obtain success in cutting hard coals with a percussive machine, there are two essential conditions necessary in order to obtain the success which has been obtained in America. These are:—(1) A heavier blow from the machine in order to obtain more rapid cutting. (2) Mechanical arrangements for taking the recoil off the operator.

The latter has been attempted in several machines, chiefly of German manufacture, by mounting an ordinary rock-drill upon a column, which entirely removes the shock or recoil from the operator. In this arrangement the cutting tool is swept round with the column as a centre, and the point of the tool acting upon the face is fed up as the cut is effected, to a larger radius, a longer tool being put in when the feed screw of the machine is exhausted. This form of percussive coal cutter has only recently been introduced into this country, and appears to have attained a considerable measure of success.

The authors, after very prolonged experiments, have produced a machine, which is exhibited, in which their aim has been:—(1) To take the recoil of the blows off the operator. (2) To increase the force of the blows on the coal face; to strike such a number of blows as will, in the hardest coal, effect an economical speed of cutting; and to mount the machine so that it can readily be removed from one part of the workings to another. This machine is shown on the lithographs supplied, and members also have an opportunity of inspecting the machine.

The means by which it has been sought to attain the conditions mentioned are:—(1) By constructing the cylinders in duplicate, so that the recoil of one cylinder is counteracted by the reaction of the other. (2) The counteraction of the recoil by means of the double cylinders enables a machine with larger cylinders and of longer stroke to be employed than is possible in a single-cylinder machine; whilst it also follows that, with two cylinders, double the number of blows are delivered. (3) By mounting the machine on a carriage of the colliery wheel gauge, the objection of weight is overcome within practicable limits; the setting is rigid and rapidly effected, and, when set, the weight of the machine and the feed-screw arrangement take all recoil off the operator, without the necessity of any column support to the roof.

Conclusions.—The authors take the view that American success is due to the punching or percussive machine, and to its adaptability to the prevailing system of mining. That, given the possibility of cutting out the narrow work in a mine rapidly and economically, the system of roads formed in the solid, as against those formed in the goaf, or longwall roads, presents in many instances considerable economical advantages, and that coal-cutting by machines adapted to these conditions is a more advantageous application than longwall machines, where the process of "kirving" or undercutting is a smaller proportion of the total labour costs than in the board-and-pillar system, whilst the latter system presents, apart from the cost of forming the first workings, many advantageous economical conditions.

They are also of opinion that the portability of the percussive machine renders it applicable to a more general extent than the heavier longwall machines, which involve requirements such as freedom from faults, good roofs, and uninterrupted stretches of coal, conditions which do not exist to such an extent as to render the application of the heavier longwall machines in all cases economical.

There is the further consideration that, whilst in the percussive machine wear and tear is practically nil and breakdown remote, in the longwall machines wear and tear is very heavy and stoppage imminent.

It is therefore the authors' opinion that, as in America, so it will be here, the percussive machine will be the one which will ultimately solve the problem of mechanical coal-cutting.

A paper was then introduced by Mr. Arthur E. T. Lees, on

"RECENT IMPROVEMENTS IN GOLD MINING MACHINERY ON THE RAND."

In view of the labour difficulty in South Africa, the introduction, wherever possible, of automatic appliances in the gold mines of the Witwatersrand has become a matter of the utmost importance, and every effort is being made in this direction. Unfortunately, the bulk of the hand labour is employed below the surface—as, for instance, in the stopes and in tramming through irregular drives—where it is difficult to use labour-saving devices. Considerable progress in this respect has, however, recently been made in the surface works, to which, as well as to certain improvements in mining machinery generally, the following notes have reference.

Haulage.—The usual type of endless rope mechanical haulage requires a considerable amount of labour for hitching the loaded trucks on and off the rope, and discharging and returning them when empty. This system is now being superseded in new equipments by motor-driven rubber-belt conveyors which are practically automatic, and effect considerable economy in working costs, the labour required for a line of transport being on an average not more than about one-sixth of that necessary with the older method. These belts are used for conveying rock from head gears to crusher house; sorted ore to mill hoppers; waste rock to dump; sands after cyaniding to tailings dump; coals to hoppers in boiler-house; while they also serve for the purpose of sorting in the crusher house.

The hoppers in the mill and boiler-houses are provided with a travelling throw-off, whereby the material can be discharged at any desired point. The resistance of the rubber surface to abrasion is considerable, and it is found that this type of belt stands wear better than those constructed of steel hitherto in use. Machines for automatically weighing and registering the weight of material carried on the belts are also being provided, and should prove a great convenience.

Boiler plants.—Water-tube boilers are now very largely used in preference to the externally-fired and other types previously in use. Although several types of mechanical stokers have been tried, they have met with but little success on the Rand, and hand-firing is practically universal. At the present time, however, chain-grate stokers, which appear to be suitable for use with the slow-burning Transvaal coal, are being tried, and, if successful, will undoubtedly effect considerable economy in labour. The speed of such travelling grates should be made to vary automatically with the steam pressure, and if mechanical draught plant be used, the draught should be made to vary in a similar manner. Independently-fired superheaters fitted with chain grates are also being installed, and will no doubt considerably reduce steam consumption. Ash-conveying plants are being adopted in large boiler installations.

Stamp mills.—These are mostly erected in batteries of one hundred to two hundred stamps, placed back to back, and driven from the line shafts by friction-clutch pulleys, which are superseding belt-tighteners. The falling weight of each stamp is now about 1350 lb., the tendency being rather to increase the weight; and the crushing capacity is about six tons per stamp per day. Inside amalgamation has been almost universally abandoned in view of the improved methods of cyanide and slimes treatment. Various types of stamps other than the gravitation type have been tried, but up to the present the latter has held its own. No system of dry crushing has yet met with complete success, but efforts are being made in this direction, and it is to be hoped that a method will be found of overcoming the difficulties of the process.

Mill engines.—It has been proved again and again to be the worst possible policy to put down a cheap and inferior class of mill engine, the loss due to frequent stoppages being an exceedingly serious matter. The most approved practice is to put down two engines of the highest class, duplicates of each other, and so arranged with quills and clutches that in the case of breakdown of one, the other can be started immediately. Thus, in the ordinary course an engine runs for a month, night and day, without stopping, until the monthly clean-up, when it is laid off and can be overhauled if necessary, the other engine meantime being ready for the next month's run. Of course, with this plan the disadvantage is that one engine is always lying idle; but, on the other hand, the plant is as free from the chance of breakdown as it is possible to make it, the saving effected by the continuous running of the mill more than compensating for the loss of interest on extra capital expended. The engines being in duplicate, one set of spares serves them both.

Winding engines.—No general solution to the problem of deep-level winding appears to have yet been arrived at. The author would refer those interested in this question to a paper by Mr. Hans Behr read before the Institute of Mining and Metallurgy in May, 1902. The tendency is, however, to avoid stage-winding, unless absolutely driven to it, on account of the double-handling of the rock and multiplication of parts; and, by the use of tapering ropes and conical drums, to provide for such depths as are likely to be reached during the next few years. Neither the Koepe nor the Whiting system allows of the use of tapering ropes, nor do they permit of winding from single compartments in case of necessity. It may not be out of place to mention some winding engines now being built in this country under the supervision of the author, to wind from shafts 5000ft. deep on the incline, corresponding to a vertical depth of about 4000ft. The load will consist of 12,000 lb. of rock, with a skip weighing 6000 lb., the rope tapering from 4¼in. to 3⅜in. circumference, and weighing 13,750 lb. The engines are cross-compound, each having one high-pressure and one low-pressure cylinder, 30in. and 48in. diameter respectively, and 60in. stroke, fitted with Corliss gear. On the crank shaft are mounted two drums, each running loose and driven by friction clutches. These drums are partly parallel and partly conical, the latter portion tapering from 12ft. to 20ft. in diameter, and holding 1250ft. length of rope, the parallel part holding the remaining 3750ft. of rope which coils once back upon itself. There are separate steam auxiliaries for operating the reversing and clutch gears and holding off the post brakes, which are put into action by heavy weights.

Rock drilling.—Where circumstances are favourable, machine drilling in the stopes is being carried on with considerable success. In narrow stopes, however, time is wasted in the frequent shifting of the drill, and unless the hanging and foot walls are extremely hard, there is the drawback of the greater amount of waste country rock brought down by the heavier blasting charges used; and this, combined with the larger amount of fines produced, which cannot be sorted, has a detrimental effect on the milling returns. Where the stopes are fairly wide and the dip flat, however, a great saving can be effected by the use of machine drills. A disease known as miners' phthisis, caused by inhaling dust arising from the use of rock drills, has made its appearance on the Rand, and various devices are being tried with a view to overcoming this trouble. Amongst them is a rock drill having a hollow steel bit, through which a jet of water is forced to the bottom of the drill hole.

Mine pumps.—For mine drainage Cornish pumps were formerly almost exclusively used, but recently electrically-driven plunger pumps have been largely installed, and attention is being given to electrically-driven multiple-disc centrifugal pumps for high lifts.

Structural.—Until recently the engine and other houses were entirely constructed of timber frames covered with galvanised corrugated iron, but these are now being superseded by iron-framed buildings of a more permanent character. The same remarks apply to pit-head gears, tailings, wheels, and the whole of the cyanide and slimes plants.

General.—Various other economies are gradually being effected, as, for instance, sidings from the railway to the coal stores of the various mines, while, in some instances, private railways are being run direct from the collieries to serve groups of mines. The question of a permanent water supply for the whole of the mines is engaging the attention of the Government. Hitherto they have been dependent on water stored in reservoirs during the wet season, but as the rainfall varies greatly the supply has always been unsatisfactory. Permanent springs of considerable capacity are found in the limestone formation to the west of the Rand, which will probably be utilised, but in any scheme pumping will have to be resorted to.

A paper was then introduced by Mr. J. H. Harrison on

"EQUALISING THE TEMPERATURE OF THE BLAST FOR BLAST FURNACES."

The importance of regularity, both in materials for the blast furnace and in the operations connected with its working, is being more and more recognised. Irregularity in the chemical or mechanical condition of the materials charged, or in the method of charging them into the furnace, causes irregularity in the working of the furnace, and in the quality of the iron produced. Irregularity in the temperature of the hot blast causes the same evils. The hot blast supplies oxgyen for the combustion of the coke, and also heat to the furnace which would otherwise have to be provided by the burning of coke.

It is clear that, if the temperature of the hot blast varies, the quantity of the coke at the melting zone should also vary, to keep the heat constant; but this is impossible.

Hot blast supplied by the reversing regenerative stoves, now almost universally used, varies between 200 deg. Fah. and 300 deg. Fah., owing to the rapid cooling effect of the cold blast passing through them. The effect of these variations is to alter the position of the melting zone in the furnace. Higher blast temperature causes local combustion, and this, following immediately after a comparatively low temperature of blast and more extended combustion, has the effect of leaving those materials which had been partly fused beyond the new melting zone. In extreme cases the natural mechanical formation and condition of these materials combine to form an arch or dome across the furnace. Parts of this adhere to the walls, forming "scaffolds," causing the furnace to hang, and produce iron of low quality and reduced quantity, until the "scaffold" is fused off.

This is a serious loss of value of product, and disorganises the whole plant, owing to a deficiency in quantity and quality of gas for the stoves and boilers.

With the old-fashioned pipe stoves there is no sudden variation in the temperature of the hot blast, and a "hanging" furnace is rarely known where this type of stove is used together with uniform materials, and a larger proportion of high grade iron is produced.

In America the regular practice is to cool down the hot blast with cold blast to a temperature which the stoves can maintain continuously, in order that the blast temperature shall be uniform, although at the lowest point given by the stoves, and requiring continuous regulation of the cold-blast admission. Perfect regularity of hot-blast temperature, with practically no loss of heat, can be obtained by interposing in the course of the blast, between the stoves and the furnace, a mass of fire-brick chequer work, which takes up heat from the blast when it is above the average temperature, and gives heat back to it when its temperature is below the average.

This apparatus, known as an equaliser, is similar in appearance to a small Cowper stove. A brick-lined steel shell, with slag wool between the lining and the shell, is filled with fire-brick chequer work, divided centrally by a wall, thus forming two chambers communicating at the top. The hot blast from the stoves is made to pass up one chamber, down the other, and out at the bottom to the furnace.

The blast from a freshly-heated stove is at its highest temperature, and on entering the equaliser first comes in contact with that portion of the chequer work which has been to some extent chilled by the blast at its lowest temperature from the stove which has just "gone off" blast. The blast from the freshly-heated stove parts with some of its heat to the chequer-work, but, as this stove's run continues, the blast it gives gradually falls in temperature below that of the equaliser, and the chequer work then returns heat to the blast passing over it. In this way there is a constant exchange of heat between the blast and the chequer work, resulting in a perfectly uniform temperature of hot blast passing to the furnace, and at practically the average of that at which it enters the equaliser. The equaliser produces blast of uniform temperature, in the same way as a fly-wheel produces regular speed in an engine. The equaliser has no valves, no attention of any kind is required, and no cleaning has to be done, as gas is not put into it.

One of these equalisers, 20ft. in diameter by 55ft. in height, was put to work in May, 1901, and gives hot blast of perfectly uniform temperature.

A second equaliser was put to work on March 31st this year, at another works, and is giving the same regular blast temperature.

A third equaliser is being erected at another works. "Hanging" has occurred with the furnace, which has worked two years with an equaliser, but in every case this has been directly traced either to the irregular quality of the ore, which is all imported, and of very varying character, or to irregular charging of the materials. No such trouble has occurred from irregular temperature of the blast.

Autographic records from Uehling pyrometers accompany the paper.

A paper was then introduced by Mr. Tom Westgarth on

"STEAM-DRIVEN AND GAS-DRIVEN BLOWING ENGINES."

It was considered that a short paper upon the subject of steam-driven and gas-driven blowing engines would be of interest to the Conference, and I, therefore, accepted the invitation to write a few notes which will form a basis for discussion.

It is, perhaps, not necessary to discuss the older types of steam blowing engines, except to remark that they must have been very suitable for the work to be done, judging from the few changes that have been made, and the long time they have worked. But the steam blowing engines which have done such good work were found a few years ago to be unsuitable for the harder work and higher blast pressures required, the development first taking place in the United States, where ironmasters had a great advantage in being able to put down entirely new plant, and, therefore, could adopt the experience of other countries. These developments followed in Europe, commencing about ten to fifteen years ago, when some of the more progressive ironmasters began to put down engines of much heavier design having compound steam cylinders, and capable of running faster and blowing at higher pressure, the type of engine used being, I think, fairly illustrated by engines built by my firm—that is, twin vertical engines having compound steam cylinders 40in. and 84in. diameter by 60in. stroke, exhausting into a separate condenser, the boiler pressure being 150 lb. per square inch. As the engines had to run in ordinary work at 50 revolutions a minute, and to blow up to 30 lb. per square inch, it was decided to equip the air cylinders, which are 84in. in diameter and 60in. stroke, with the sliding valves made by the Southwark Foundry and Machine Company, of Philadelphia. These valves proved to be a great success, as the clearance is reduced to 1½ per cent.; the inlet valves are worked by mechanical gear from the shaft, and the outlet valves are closed mechanically, but are re-opened automatically by the air pressure, the arrangement being such that, when the pressure in the cylinder and in the mains is balanced, the valves are slightly lifted from the face and are pushed open by a controlling cylinder actuated by the air pressure, so that the arrangement is not only automatic, but practically frictionless.

I understand that a set of triple-expansion vertical blowing engines with three cranks has been working for some time in West Cumberland, with satisfactory results; but, as I have not seen the engines, I am not able to do more than refer to them.

The next step which I took in the construction of steam-blowing engines was to adopt the so-called quarter-crank arrangement which was developed by the Southwark Foundry and Machine Company, of Philadelphia. With the increasing piston speeds, and particularly the increasing blast pressures to be dealt with, it became evident that some alteration would have to be made in the ordinary design of steam-blowing engines. With the usual plan of having the steam and air cylinders in line and working upon the same rod, it is found that serious shocks occur at each end of the stroke when using high-pressure steam and blowing against high pressures, because whilst the steam pressure must be admitted into the cylinder at a very early part of the stroke, the full resistance does not accumulate in the air cylinder until a much later part of the stroke. Although this difficulty exists in a smaller degree in all ordinary blowing engines, it was not found to be serious with low speeds and low pressures; but it was found to result in frequent accidents when modern requirements were being fulfilled, and the quarter-crank engine was, therefore, designed to overcome the difficulties. The arrangement, which will be readily understood from the photograph exhibited, consists of an ordinary inverted vertical steam engine acting upon a crank shaft and fly-wheel. Upon the opposite end of the crank shaft from the fly-wheel is fitted another crank, which, by means of the usual gear, works an inverted vertical blowing cylinder placed side by side with the steam cylinder; it will be seen that the cranks can be placed at such an angle that the shocks referred to can be avoided, and that this type of engine can, therefore, be run at much higher speeds, blowing at high pressure with perfect smoothness and safety; indeed, these engines can be run so much faster that although at first sight expensive, they are not much more costly than an ordinary vertical engine when the quantity of air discharged is considered. It will also be observed that the high-pressure and low-pressure sides of these engines are quite separate, being connected only by the exhaust from the high-pressure to the low-pressure cylinder, which passes through a re-heater, so that if either half of the engine is laid off for repairs or by accident, the other half can be kept going. The engines are fitted with the sliding valves already referred to. These quarter-crank engines have been largely adopted in America and in England. My firm have a number of sets in hand, and we hope to be ready to show a set in work at Barrow when the Iron and Steel Institute meet there in September.

It recently became evident that blowing engines worked with gas are particularly suitable for blast furnace work. I therefore investigated the matter fully and carefully, and finally made

arrangements with the Société Anonyme John Cockerill, of Seraing, to build gas-driven blowing engines to their designs and under their patents, and I shall speak more particularly of the Cockerill engine as being the one I understand best. No doubt others will be able to give us information as to the Körting, Oechelhauser, Crossley, Premier, and other gas-blowing engines, the object of this paper being to invite discussion on these matters.

The Cockerill Company were the pioneers in the making and using of large size blowing engines to work with blast furnace gas. Their engines work upon the Otto cycle, and for blowing work have usually one single-acting cylinder. My firm is now developing the same arrangement, but with double-acting gas cylinders, for blowing work, but more particularly for dynamo work, which does not come within the scope of this paper. The air cylinder of this engine is fitted with a large number of small circular valves. These have proved to give very good results at speeds up to 80 and 90 revolutions per minute, but I am now building two of these engines fitted with the Southwark sliding valves, from which I expect still better results, as I think the sliding valve mechanically controlled will prove to be more suitable for the high speeds at which gas engines must run to be economical. The engine shown in the photograph has a single-acting gas cylinder 51½in. in diameter by 55in. stroke, a blowing cylinder 72in. in diameter by 55in. stroke, and is to work at 80 revolutions per minute.

Having now spoken of gas and steam blowing engines individually, we will pass on to what is at present the most important and most interesting part of the question, viz., as to whether steam-driven or gas-driven blowing engines are more economical and more suitable for the work to be done, and I have no hesitation in saying that, speaking generally, in my opinion the gas engine is more suitable, providing always there is a ready means of using the gas which will be saved by using the gas engine. If an entirely new steel works with blast furnaces, &c., is to be put down, undoubtedly the whole of the blowing power for the furnaces should be derived from gas; and if the gas be cleaned, as it should be for the stoves, it will be found that there is a considerable surplus which can be sent to the steel works, boilers, or used for gas engines to generate electricity; but if a blast furnace plant is to be erected without steel or other works, and there are no other outlets for surplus power, there is probably not much difference between using steam-driven or gas-driven blowing engines, but in these days of universal application of electricity it is very unlikely that a blast furnace plant would be erected where surplus power could not profitably be used. I think the question between steam-driven and gas-driven blowing engines is more open for consideration where existing works requiring increased blowing power have to be dealt with, and then it would turn largely upon a question of existing boilers, condensers, &c.; if these are ample and are in good condition and there is no easily found means of using surplus power, many people would prefer to put down steam-blowing engines; but if a condenser and new boilers have to be put down it would appear to be wiser, instead of using steam-blowing engines, to adopt gas-driven engines. To consider the whole question it may safely be assumed that the quantity of gas used by gas-driven engines would be about one-fourth that required to raise steam in good boilers for steam-driven blowing engines. It may also be considered that broadly the cost of a steam-driven blowing engine of modern construction, say a compound or triple-expansion engine with Corliss valves and mechanically-controlled air valves, together with the necessary boilers, condensing plant, &c., will be somewhat more than that of gas-driven blowing engines with the necessary gas-cleaning plant, for a given amount of work to be done. It may also be assumed that the consumption of oil for a gas engine will be slightly greater than for a slower running steam engine, although not much, this matter of oil consumption having been greatly exaggerated; and also that the consumption of water for a gas engine will be less than for a steam engine.

There was but a small attendance in this section, and practically no discussion followed the papers.

SECTION VII.

After the presidential address had been delivered, Section VII. met in the Committee Room in the Westminster Guildhall.

Mr. Alexander Siemens took the chair at 10.30 a.m., and after a few introductory remarks, Mr. Edmund A. N. Pochin read his paper on

"WIRELESS TELEGRAPHY."

This subject offers a wide field for discussion both on account of its novelty and its far-reaching possibilities. Recent developments have aroused much interest, and some very important facts have lately been established. (1) Up to considerable ranges earth curvature is not a fatal obstacle, but hills may exercise a serious influence. (2) The other exhibits what we may provisionally call a variable transparency to Hertzian waves, sunlight being an important factor. With regard to both of these phenomena, it is probable that certain wave-lengths offer special advantages; whilst the second affords a faint clue to the relative share of earth and ether in transmission. Amongst problems, that of isolation is undoubtably the most important, and in this direction two methods have been employed which may be termed respectively Syntonic and Optical methods.

Syntonic methods.—The vertical wire or network commonly used must, of necessity, radiate equally in all horizontal directions, and, therefore, frequency alone is available as a means of discrimination. The conditions for sharp tuning are well understood, and theoretically a high degree of privacy seems possible. The most exaggerated ideas are, however, current regarding what has hitherto been attainable in practice. At present there is no property in special wave-lengths, and although central control provided by international legislation may do much to prevent interference, messages of this class must always remain open to interception over a large radius by syntonised instruments, or by untuned apparatus at closer quarters. And although the latter may sometimes be checked by interference signals, superposed on the original message, the plan cannot be regarded as final; nor, again, must we overlook the effect of atmospheric discharges.

In the closed circuit system with two syntonised coils, one for transmitting, and the other for receiving, sharper tuning is practicable; and if the coils are vertical, an element of direction is also secured. This method is unaffected by atmospheric electricity, but is comparatively deficient in range. Mechanical tuning may be mentioned, involving the use of reeds or tuning-forks, in addition to the electrical portions; but it should be noted that sharp tuning at low frequency must imply slow signalling. No detailed information is available regarding the more recent earth conduction methods.

Optical methods.—It is unfortunate that so little attention has been devoted to the use of lenses and reflectors in connection with Hertzian waves for telegraphy. Not only would great privacy result, but we should also be able to give a ship her position. It would be hard to overate the importance of any system for effecting this reliably, even over so short a range as 10 miles, and with an accuracy as low as 50 per cent. The obstacle which confronts us at the outset is our present inability to radiate a large amount of energy from a small area. So far, a distance of about two miles is credited to their use. Allied to the foregoing is photophonic signalling, depending on the properties of selenium.

General remarks.—The lack of a satisfactory metrical detector has been a serious bar to progress by small gradations, making research highly tentative and laborious. The ability to employ some form of galvanometer would enable curves to be plotted and maxima and minima rapidly determined for each variable. For the production of wave-trains we still depend on a condenser discharge. The resulting oscillations are no doubt sufficiently sinoidal for the most exacting; but in view of dissipation by brushes and other causes, may not their strict isochronism have been too hastily assumed? Any deviation must be highly prejudicial, as the radiator and receiver would tend in opposite directions. The wide and irregular variation between successive discharges is another difficulty which can be best appreciated by those who have worked with condensers. Alternators have been built with a frequency approaching 30,000 per second, and seem to deserve a reference in this connection.

The discussion was opened by Sir W. H. Preece, who said that he had worked at the subject of wireless telegraphy for the last fifty years. The first test of which he was aware was made by Lindsay, of Dundee, and since that date improvements had followed. It was the first time he had heard a paper by a man who knew much about the subject. There had been a great deal of mathematical calisthenics on previous occasions. Seven years ago, in 1896, Mr. Marconi came to him and appealed for Government assistance, and the Postal authorities had given him all the aid possible, although many unkind remarks had been made about the want of interest shown by the Government. Very little was yet known about the ether, and the action of the earth could not be ignored. The Hertzian waves possibly go through the air and return by the earth. The only real novelty referred to in the paper was the alternator of high frequency. There was a vast difference in the distance to which messages could be sent over sea from that possible over land. The speed of signalling to long distances over sea might be five to ten words per minute. In Germany it was stated that a speed of fifteen words had been achieved, and with the Fessenden apparatus it was said thirty-five words per minute had been transmitted. There was not one single practical commercial system at present in use.

Mr. Maskelyne said he had experienced great difficulty in experimenting on this subject. There was nothing like it outside the range of transcendental physics. Wireless telegraphy was a misnomer; it was not wireless, nor could it be called telegraphy. Even in transmitting from a ship to a shore station he had observed that one hour had been spent in the endeavour to signal that there was nothing to say. An electrical disturbance was produced in the atmosphere similar to that which shakes windows when a gun is fired at sea, and any local electrical disturbance would have the same effect upon the receiver. The law of inverse squares was applicable, and he considered the system only useful as an auxiliary to existing systems. At present the only practical use was in transmitting messages from ship to shore.

Mr. John Gavey said that syntony was the most important matter, and in order to make conclusive experiments two or three land stations and two or three vessels would be necessary. A syntonised installation, 50 or 60 miles in length, could probably be maintained in regular work. Sharp tuning was practicable, but not very effective in preventing interruption. If an untuned instrument were worked near a tuned instrument there would be interruption unless the wave lengths of the two apparatus were very different. Out of several types of receivers he had found that a sharpened carbon pencil, resting upon a steel spring, with a spot of oil, would pick up almost anything, and was a very effective apparatus for research. At present the electro-magnetic and leakage system could, in his opinion, be used to an effective distance of say eight miles.

Mr. Granville considered that Mother Earth had more to do with the subject than the ether, and he had made experiments with Mr. Willoughby Smith. He considered that there was a layer of high vacuum at a height of 50 or 60 miles above the surface of the earth, and the earth might be considered as wrapped in a non-conducting sheet of tissue paper, which represented the atmosphere having a sheet of tin-foil wrapped above it, the latter representing the high vacuum layer. The curvature of the earth rendered it difficult to send messages for long distances, and he thought that for successful work the two stations must be in a direct line of sight. He described wireless telegraphy as a one-circuit system.

General Webber agreed with Sir W. H. Preece, and thought that the earth return had a great deal to do with the subject. As to the attenuated layer referred to by Mr. Granville, he saw no means of testing it, either by balloons or otherwise. If earth plates were buried an area of disturbance could be set up. This method had been tried in wells and also in mines, and signals had been successfully communicated. Captain Jackson had probably made more experiments over the sea than anyone else. He knew of a ship entering the harbour of Gibraltar and finding it impossible to pick up messages from the land. This was found to be due to the position of the receiving mast, which was directly behind the four funnels, and was thus shielded from the ether waves.

Mr. Alexander Siemens considered that in order to do any good and to solve the problem, it was necessary to apply the system to purposes for which it could at present be used, say from a ship to the shore. It was also possible to communicate with trains in motion. He considered that Mr. Marconi had tried to run before he could walk in attempting to transmit messages to vast distances. Wireless telegraphy resembled a system by which an individual was enabled to shout very loud so as to be heard miles off, but if many people were to indulge in this at the same moment it was obvious confusion must ensue.

Mr. Pochin then briefly replied, and said it was regretable that the halfpenny paper was the chief source of information on the subject. There had been far too much sensational news. They wanted a metrical coherer which would enable laboratory experiments to be relied upon in making calculations for practical work. If they could send messages as far as the light from a lighthouse would reach it would be a great step in advance. An earth plate earthed and placed in the line of waves would effectually check the transmission of any messages.

Section VII. then went to the Institution of Mechanical Engineers and joined Section III., and heard the two papers, "Internal Combustion Engines for Driving Dynamos," and "Gauges and Standards as Affecting Shop and Manufacturing Administration," which are discussed above.

DOCKYARD NOTES.

THE remarkable increase in speed secured by the County class as the result of the new propellers has been the cause of a good deal of wild speculation ever since. In some quarters there has been exhibited a tendency to demand the "re-screwing" of the Navy. Thus, the enthusiast who is enthusiastic first, and technical afterwards—a long way afterwards at times—tells us that the 19-knot Duncans will probably become 21-knot battleships, the Canopus class will do over 20, even the old Admiral class will be almost 18 knotters perhaps, and all our old 18-knot cruisers, now obsolete from lack of speed, will be given a new lease of life. It is a pretty picture—very; but we fancy a great deal of water will have to slip past the propellers of the Admiral class before the happy day arrives. However, since agitation must always be with us, we dare say that a "screw" agitation will be quite as beneficial as the one for "capped shell" and a few other fancies.

THE "cap," by the way, is now official for the British service, but not for the projectiles that came under the wing of the agitators. In future A.P. shot are to be iron capped. The latest experiments indicate that the loss of penetration—or "perforation" as they call it on the proving grounds—is not excessive at angles. If a shot hits normally or anything nearly like it then the gain will be considerable, very considerable, supposing the gun to have a velocity that on service it has not got. The chances of such hits in battle are about ·01 per cent. or so—still, there is nothing like being armed for the off chance.

THE recent French trials, in which the Henri IV. and some sheep figured, seem the subject of a good deal of misunderstanding. What really happened was simple enough, and for uselessness is worthy to rank with our own Belleisle experiments. The turret experimented with was the after big gun one, over which a 5·5in., that is placed a little over it, was fired. The sheep were inside the turret where a gun's crew would have been. No sheep's head, however, was in the sighting hood where a man's head would have had to be, and the blast problem is about that man sighting the gun, not about the men stowed inside. The experiment, therefore, was in no way conclusive of anything. The story about the big gun fired across the battery appears to be purely invention. The real facts were the mild ones that we have given.

IT is probable that a new type of conning tower will soon be "sealed pattern" for the British Navy. The new tower will be half the size of the old one, able to hold two men only at the utmost. In a chamber below, the standard compass, &c., will be placed, as well as all the communications. Orders will be shouted down to this chamber, or passed by written message. In essence this type of tower is much the same thing as an ideal tower sketched out in THE ENGINEER about a twelvemonth ago, with one important difference. Our ideal tower was not a tower at all, but a flat surface with splinter net walls instead of armoured ones. However, the shell-bursting area will be greatly reduced, and that is an excellent thing. But we are still of opinion that our device would have been better.

IT is worthy of note that in French and German ships the tendency is in an exactly opposite direction. In these the tower grows bigger and bigger, and assumes an oblong shape. Such towers are probably the result of experiment, and they are not illogical, but the best alternative is no tower at all. Their virtue lies in their size. However big they are, a big shot can only hit them by pure chance, and in view of the small number of big A.P. that will be fired, the odds are something like one in three thousand or more. Even if hit by this odd shot, the towers are so thick that it would not matter. They are so big that concussion should not be very bad inside, where there is ample room for everything to be well clear of the armoured walls. The things that will hit will be shell. Here again bigness tells; things inside will be clear of the concussion. Thus and so far are the French and German towers logical. Of course, they weigh a good deal, but weight-saving can be easily brought into line with lunacy if carried too far. We heard of a lunatic once who tried to cut off his legs so as to rival some light-weight jockey. Even if he had not been shut up we do not think he would have won the Derby, despite the economy of weight effected. There are certain gentlemen in the Constructive Department who might ponder over this story in their wild desire to "save weight."

THE INSTITUTION OF ELECTRICAL ENGINEERS.—On Thursday, the 11th inst., in connection with the recent telegraph conference, the President of the Institution of Electrical Engineers gave a concert to the delegates attending the conference, as well as to the members of his own institution. The concert was held in the Albert Hall, and it was excellent in every way. In spite of a most inclement evening the Hall was nearly full. The vocalists included Madame Clara Butt, Madame Albani, Mr. Andrew Black, and Mr. Ben Davies, while Miss Marie Hall gave three violin solos. It was a concert to be remembered, and we are certain that every one of the thousands of guests must have spent a most enjoyable evening.

REFRIGERATING PLANT.—A great deal has been said lately about the expedition with which orders are executed on the other side of the Atlantic in contrast to the alleged easygoing ways of British manufacturers. It is, therefore, satisfactory to be able to record instances showing that British firms are abreast of their American competitors, including rapidity of delivery. Such a case has just occurred to the fitting of the Canadian Pacific Company's new s.s. Lake Michigan with a refrigerating plant. J. and E. Hall, Limited, of Dartford, the well-known refrigerating engineers, received the order for this work on April 29th last, and the plans of the holds to be fitted were finally decided upon and passed on May 11th. The refrigerating machine, which is of considerable size, had to be entirely constructed, as the manufacturers did not happen to have even the parts of the machine in stock. The machine was actually completed and tested on the 20th of the same month, and twenty-four hours after leaving their works the machine was in place on board the ship in Liverpool, the erection and completion of the machine taking only a further four days. The ship sailed with all complete on May 26th, so that there were only actually twenty-five days, or, deducting Sundays, twenty-one working days between the time that the machine was ordered and the time that it was in working order on board the ship. Deducting the twelve days during which the plans were being prepared and agreed, only thirteen days elapsed during which the insulation of the holds and the fitting of the brine pipe grids were completed. This is a record any firm might well be proud of, and points to a highly efficient state of organisation on the part of both the contractors and the owning company's staff, the latter having co-operated in every way.—*Fairplay.*

H.M.S. CENTURION RECONSTRUCTED.

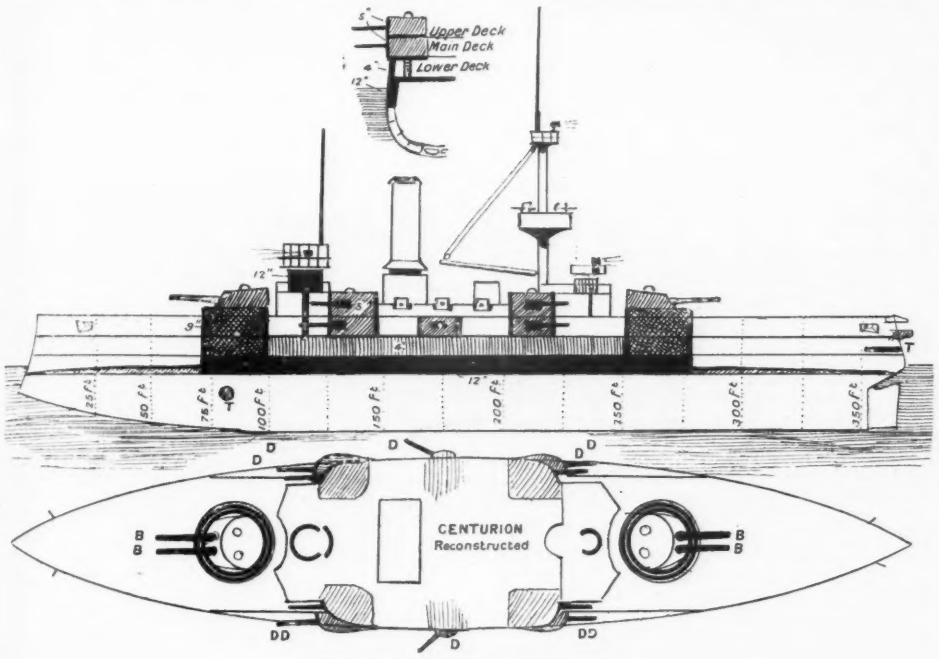
SPECIAL interest attaches to the reconstruction of H.M.S. Centurion, as she and her sister, the Barfleur, are the first British warships of recent years to be really reconstructed. The work done to the Royal Sovereign class is reconstruction in name rather than in effect; the Centurion, on the other hand, has been submitted to treatment worthy of the name, though whether the ship will be really the better for it is another matter.

As originally designed, the Centurion, on 10,500 tons, carried four 10in., and ten 4·7in. quick-firers. Her armour, mostly compound, is, a 12in. belt running for half her length, topped by a 2½in. flat deck. Above this a 4in. Harvey belt and bulkheads forms a redoubt protecting the lower deck. On the main deck above, four casemates carried four 4·7's—the remaining six guns were on the upper deck, with no protection save the purely nominal defence of shields.

The 10in. guns were, and still are, protected by 9in. compound barbettes, of circular pattern, carrying the hooded turrets which, first embodied in these ships, have, with alterations, become "sealed pattern" for all our warships. These old turrets remain.

The Centurion on trial, with 13,214 horse-power, made 18·5 knots, but at sea afterwards this speed was often exceeded. Both she and the Barfleur were always excellent steamers, and always, too, popular vessels on that account. Their armament, however, even in the days when they were new ships—that is some ten years ago—was always described by naval officers as "ridiculous." Nor can the most determined official apologist say anything to the contrary. A broadside of two protected and three unprotected 4·7's is all that the critics have called it.

Now, these have been replaced by 6in. Mark VII., carried



THE RECONSTRUCTED CENTURION

all in 5in. Krupp non-cemented casemates. The weight of these is approximately 20 tons each—say 200 tons for the lot. Each new gun with its mounting means about 13 tons. From this deductions can be made on the weight saved on the old 4·7in.'s, four old casemates and the absence of cartridge cases for the new pieces. All told, the new ammunition will not weigh so very much more than the old—at least, there will be a relatively trifling increase here, thanks to the "bare charge." Altogether, however, with her new guns and casemates, the Centurion will have 200 tons more to carry, or would have but for ameliorations elsewhere.

Of these the chief is the removal of the old foremast, which is said to have weighed little short of 70 tons. Here at once the balance begins to get adjusted, but one is tempted to ask why on earth in the original design a mast was preferred to gun power.

A further amelioration—though not of a weight-saving order—will tell in favour of the new Centurion. In the old ship six guns were on the upper deck, in the new there are only four, the heavier section being placed low. This is a better disposition of weights, though doubts have been expressed as to how these guns will fare in a seaway. Quite possibly they will not be fought, or, if fought, extreme difficulty may be experienced. However, there will certainly be less roll, so the choice cannot be criticised. It will be noted that four guns fire ahead—rather late in the day this defect of the original Centurions, one repeated in the Renown and Majestic class is being corrected. The placing of the casemates is practically identical in system with that adopted in the London, save that there is a gun less each side.

It is rumoured in the Navy—with what truth we cannot say—that both the Centurion and Barfleur float deeper in the water than the design allowed for. This—say the cynics—accounts for their excellent speeds; a best possible in the way of lines having been stumbled on in error. Be this as it may, the ships have an excellent record. There is some doubt as to what they will do with the extra submerging that the alterations will entail. It is no great amount—a few inches at the most—and, from what we remember of the Centurion's steaming with her excess coal supply, is not likely to spoil matters.

It is interesting to note that, enormous as is the relative change made in the Centurion's armament, we are still far from over-gunning her. The German Kaiser class carry 9·4in. guns that weigh little if at all less than the Centurion's 10in.; they are not quite as speedy, but still relatively swift; they carry a considerably greater weight of armour, and eighteen 6in. guns, where the Centurion once had ten 4·7, and now, after a "desperate plunge," carries ten 6in. Evidently, ideas as to what a warship is to do, and what she can carry, differ according to which side of the North Sea we are. The Kaisers are very little heavier, but there is no question about their gun superiority. They are not of very much later date than the Centurion in conception; but how the two ideas, one of ten 4·7in. popguns, and the other of eighteen 6in. as secondary armaments, are to be reconciled, we cannot say. But it would certainly look as though both cannot be right. An illustration of the reconstructed ship appears upon page 622.

FRICTION AND LUBRICATION.

By J. STORMONTH.

THE subjects of friction and lubrication have had considerable light thrown on them by the experiments of Mr. Towers, and also by those of others. That the results of these experiments have had the full effect they deserve is doubtful. Such investigations have been chiefly devoted to such matters as the coefficients of friction with different lubricants and under different pressures and conditions. Not the least valuable points have been those connected with the introduction of oil between bearing surfaces.

There is still much to be learned regarding the friction of metals on metals. Attempts to formulate laws of friction really stultify investigation by drawing away attention from the nature and effects of friction, through all the gradations of resistance, wear, and seizing. From one point of view the principal attention is directed to coefficients of friction and pressures per square inch on bearings. From another point of view there is the important question of wear. Wear not only entails work in renewals and repairs, but also entails the danger of a bush or bushes being cut through, and journals becoming damaged through contact with cast iron.

If oil is poured on any journal revolved by hand the effect is marked. The running is easier. If we consider the layer of oil as made up of a series of films, one film is on the journal, another on the bush, and diffusion takes place between the particles composing the intervening films. As the journal revolves the oil exudes at the ends between the journal and bush, and the number of films becomes less. As they do so the diffusion probably changes to shearing action as the resistance of the particles to free movement becomes greater. The behaviour of red lead putty when a joint is being made is suggestive.

When red lead putty is placed between two machined faces as, say, on pipe flanges, the putty exudes at the edges under the stress of the bolts. This action goes on till the friction between the layer of lead and the faces, and also the friction of the particles between themselves, balance the stress of the bolts. The exuded lead is thinner in consistency than the original putty, showing that the less viscous particles have exuded. Should such a joint require to be broken before the red lead is hard, it is a practice with some to spread a little tallow over the red lead, and when the joint is again screwed up more putty exudes from the edges. This shows that the particles of tallow penetrate through the layer of red lead, carrying particles of the red lead with them.

A similar action takes place with oil or grease. The thinner, or it may be the finer, particles exude until the friction between the journal and bush prevents the films of oil decreasing in number. When this point is reached, the movement of the revolving journal tends to release oil at the edges, unless a fresh supply of oil compensates for the leakage. Were there no leakage and no evaporation, the thinness of an oil would be a recommendation in all cases, seeing that fluids are practically incompressible. As matters are, more viscid oil, that is, oil having greater friction between its particles, is used for heavy pressures than is used for light pressures.

Should the film of oil prevent metallic contact, no wear will apparently result unless there are abrasive particles among the oil; otherwise the projecting particles of the bush are seized by projecting particles on the journal. If very small particles are detached from bush and journal respectively, which can float through the oil layer without rubbing either surface, or only to a slight extent, polishing of the surfaces may result. This is most noticeable in stiff journals not liable to deflection, unless of a slight and uniform character. Accurately working crank pins are sometimes an example. So are heavy rolls of close-grained metal, working under moderate and uniform pressure. If a bush is of inferior bearing metal, as brass, the particles of the bush may yield to the particles of the journal sufficiently to cause a less or more uniform wear of the bush. The particles may be carried off by the oil. Light pressure on a bearing favours this action.

The heating or seizing of a bush presents points of interest—sometimes of painful interest. Let a crank pin 6in. by 6in. be subject to an initial pressure of, say, 800 lb. per square inch (diameter × length). The bushes are let together slightly, and cottered or bolted hard up. But the bushes have been let together rather more at one end than the other. One half of the bush is kept in position by the connecting-rod, and is therefore as it was before. The other is slightly tilted, so that the pressure falls on one end of that half. The increased pressure at that end causes seizing of one or two particles. This favours the seizing of others. With good bronze, whose particles offer considerable resistance to rupture, heating above the normal temperature commences and increases. This favours increased seizing. The points favouring an inevitable shut down in such a case are increase of heating, owing to the roughened surface of the bush, and possibly of the journal; the bush beginning to seize at the side through the journal slightly deepening into the bush, and by expansion of the crank pin. The points favouring continuance of running are the washing out of the abraded particles through extra supply of oil, and extra oil supply increasing the oil films between the bearing parts, and extension of the bearing surface through the rapid wear increasing the amount of bearing surface. Water applied externally carries off heat by conduction. And a little water mixed with the oil passing into the bearing comes into contact with the most highly-heated particles. This is evident from the heat of the drops flying from the crank pin. The increased heat renders the oil more fluid, and the question arises, does the water merely cool the highly-heated particles, or does it act as a slight abrasive, rubbing down the roughened particles? A little trickle of water along with oil is often very effective in reducing the heat of a bearing beginning to seize.

In open bearings, where a journal has room to expand, a high heat may be generated by friction. In a journal shaft heat is carried away by conduction, and the resulting smell and smoke from grease on journals, &c., calls for drastic measures. An end journal, however, running in a bronze bush has been seen to glow with nearly a bright red heat when lubrication had been neglected.

It is apparent that the surface particles of a journal are stressed in turning; some may even be strained, the amount of stress and strain depending on the material, or the state of the material being cut and the amount of cut. Obviously, a light and easy cut, which will remove the particles already strained by a heavier cut, is beneficial. It is the practice in good work to finish off a journal with a light cut to obtain smoothness and circular exactness.

In filing, say, a flat surface, a smooth file, even after the roughness of the surface is removed, not infrequently removes particles which are larger than the filings, and which become imbedded between the teeth. These cause scratches. Hence the workshop expression, "Deep scratch and high polish." To avoid these the file is frequently rubbed with chalk, and brushed with a wire brush when scratching commences. Malleable iron and steel show this action chiefly, though there is considerable difference in the forgings of either metal. In bedding a new journal into a bush, it not infrequently happens that one or more particles become imbedded in the bush, and, scoring the journal, require removal. In such cases there is not the uniform bearing which is produced under wear, but neither is there the pressure, generally, which exists under running conditions. It would seem that these particles are either strained in the machining, or that the particles are more or less segregated. With moderate pressures it seems to me that scoring is most apt to occur with new journals, while the heating of an old journal—one which has been in use—frequently increases scoring. Some journals, owing apparently to their nature, score more readily than others.

Bearing metals still offer a large field to investigation. They may be viewed in two ways, either as having fine close particles which, while softer than the journal, offer resistance to separation, and when they separate, do so as dust, or as compound metals, of which compound one forms a matrix for the others. Bronzes are of the former class, and the closeness of their grain is apparent from the fact that a file which fails to seize bronze may be practically as good as new for filing iron or steel.

If it is the case that high-speed steel tools owe their effectiveness to the fact that the harder cutting particles are supported by a matrix of material not so hard, we have a clue, it would seem, to the class at least of anti-friction metals which have a large proportion of lead. The softer material would seem to support the harder, but, unlike the steel, give way to pressure. The use of emery cloth may serve as an illustration. There are coarser and finer grades of emery supported in a matrix, as it were, of cloth and adhesive material. A sheet of emery cloth fixed on a cast iron cylinder will cut with more effect than when it is wrapped round a piece of wood. The iron and wood respectively form part of a combined matrix. In using glass-paper cabinetmakers wrap it round a flat piece of cork.

A particle of emery of a certain grade coming against a particle of metal will remove a larger amount of the metal particle when held down by a file than when held down by hand. When finishing by hand pressure only the finer polish is due to the combined matrix of adhesive, cloth and hand. A finer grade of emery cloth wrapped round a file may give a polish nearly similar to a rougher grade applied by hand, but the rougher emery is liable to give a more scratchy surface, due probably to a hooking action of some of the particles. If, then, harder particles of the anti-friction metal rub on the journal, but when seized by the journal particles yield into the softer metal of the matrix, we have an explanation of the polishing action on a journal of the anti-friction metal. A case came under my own notice where a new cast iron journal, which was somewhat porous, began to cut up along with the bronze bush. This was probably due to loose particles of the cast iron, as the bearing pressure was only about 70 lb. or 80 lb. per square inch. A layer of Babbitt was run on the bush, and in the attempt to file the journal smoother after the cutting the point of the file became accidentally fixed between journal and bush, making an indentation and corresponding ridge on the journal. The Babbitt polished the ridge and journal, the action evidently being that the Babbitt resisted the ridge sufficiently to polish it but not sufficiently to tear the journal. Should a journal wear through a bush and come into contact with cast iron, the effect usually is a badly cut journal; the rough grains of cast iron, aided probably by the harder particles of the skin of the casting, acting as abrasive material. With light pressures cast iron bearings frequently give good results if a skin becomes formed on the machined surface of the cast iron. It seems to me that residual matters among the

oil adhere more to cast iron than to malleable iron, increasing friction though lessening wear. Loose pulleys are sometimes an example of this. Heat accelerates deposit, as when steam passes through a cast iron journal revolving in a cast iron bush.

When a bush wears through it is evident a considerable amount of power has been consumed, especially in the case of bronze bushes, where the particles are removed as dust. When it has been principally caused by the closeness of the bushes, then, in addition to the power lost in wearing the bushes, extra friction must also have been caused in the lubricant through the thinness of the layer preventing free diffusion.

The amount of circular bearing surface on a bearing is a matter of great importance. Thus, should a bearing subtend an angle of 140 deg. and be in such a condition that a layer of oil = 0·005in. extends uniformly round it, then if, through failure of lubrication or otherwise, the journal wears vertically into the bush and metallic contact takes place at the ends of the bearing surface, the oil is unable to enter. If we make the arbitrary assumption that there are five films in the layer, the intermediate three at least are excluded and the skin films alone exist. It is not possible in such cases for the oil to enter, and there is thus less or more metallic contact all round the bearing, causing constant and, it may be, rapid wear. It may be taken for granted that, when this closing at the sides takes place, inevitable wear will be the result.

Bushes for steadily-revolving journals should always be bored easy. One-sixteenth of an inch clearance on a 6in. diameter journal gives little more than line contact at bottom, but this soon broadens out, and the oil reaches the bearing surface by a gentle inclination. Such bushes with moderate pressures will wear indefinitely. The less the arc of bearing contact the less variation there is in the concentricity of the bush and journal to each other with different thicknesses of oil layers.

Journals subject to to-and-fro motion, such as those of crank shafts, do not, of course, wear into such close fits in the bushes as those which revolve steadily, and the sides of the bushes are frequently the principal parts where wear takes place. This is sought to be avoided by the use of the well-known diagonal blocks. It is rare to find, however, the amount of angle of diagonal blocks so well judged that the resultant wear due to the thrust of the piston and the weight on the journal will be in the same diagonal line as that of the block. It is apparent, on a little reflection, that if the wear is in the direction of the thrust, tilting the bushes together causes seizing on the top part of the journal, while it does not stop the thrust play unless the upper part of the top bush is relieved. With vertical engines, as the ordinary type of marine engines, the wear from both causes being downwards, or, at least, in the vertical direction, avoids trouble from this cause. With other than small horizontal engines bushes are commonly made in sections.

In some cases end motion is sought to be imparted to a crank shaft. This motion is found to be favourable to lubrication. End play is allowed between the collars of the journals in such cases. As far as I am aware, this endwise action is most favourable with two-part bushes. Movement of the shaft tends to smoothness of the bearings, through small ridges mutually wearing each other. But the fact of a shaft moving endwise, to whatever stresses the movement is due, implies release of the journal from the sides. It is not conceivable that bushes under a constant stress, as that induced by ropes, will move on end. The tendency is for bearings in such circumstances to lock themselves from end movement by irregular, even if minute, wear.

If a crank shaft is stressed by ropes in one direction, it will be stressed in the opposite direction by the piston every other stroke. It is then released, and end movement most probably takes place. The fact of the end motion shows there is room for the oil to get down to the bearing—the bottom of the bearing. Such a shaft, on a 600 horse-power engine, came under my own cognisance. Unless the shaft moved, there was a tendency for the bearings to heat, and at one time it was found impracticable to keep it cool until the bushes were taken out and relieved down the sides. This showed how previous remarks on the difficulty of oil getting down in the case of close bearings applied in this case.

Where shafts are exposed to alternate stresses, as those of belts pulling in different directions, the resultant effects are favourable to the keeping of the bearings open at the sides. With diagonal or nearly vertical belts the effect on the bottom journals is to lift them up, and in favourable cases such bearings may almost float. The stress of belts, as a rule, is more disadvantageous to bearings than the action of wheels. The jar of wheels and the lack of such side stresses as often exists with belts is favourable to lubrication, and lessens the pressures per square inch on the bearings in many cases. With the double helical wheels, it is always advisable if possible to allow end play to one of the shafts at least, to allow of the centre lines of the respective wheels mutually adjusting themselves.

In the experiments conducted by Mr. Towers, and also in those conducted by Professor Goodman, attention has been directed to the effects of oil grooves. An interesting feature in paper manufacture is that particles of the newly formed sheet of paper tend to adhere to the surface of the rolls between which it passes. Such particles are removed by a blade of steel or bronze from $\frac{1}{16}$in. to $\frac{1}{4}$in. in thickness, and with a sharp edge which rests on the surface of the roll. These blades skim all particles of paper, as well as the larger part of the moisture, from the roll surface. Usually they are set at an angle of about 150 deg. with the roll. Grooves cut in bushes in line with the axis have their sides at an angle of about 90 deg. When corners are taken off bushes at the partings, they are commonly at an angle of about 45 deg. Bushes are in their under halves sometimes released at the sides to nearly the ends, and cut down, say, 1in. on a 5in. journal. The junction of this relieved part with the bearing is sometimes rounded, but tends to wear to a sharp edge, though the angle is obtuse. This in the case of half bushes is necessary when only the under half of the bush is used. But journals which press downwards or sideways are lubricated far better when there is no break in the surface of the bush. Even the parting, that is the junction of the two bushes, is in some cases detrimental to efficient lubrication. A diagonal bush 7$\frac{1}{2}$in. by 17$\frac{1}{2}$in. would not keep cool even when continuously oiled by means of a pump, unless the under parting of the bush which was well down to the bottom was jointed with jointing material. The pressure at that point forced the oil through what was probably an inexact fitting joint.

The lack of surface continuity seems to me one of the drawbacks to the use of ordinary anti-friction metal bearings. The rounding of the different sections at the running-in edges to some extent mitigates this drawback. Bronze bearings in sections have sometimes failed owing to lack of continuity of surface, even where the bearing surface was ample. The fact of the severe pressures on the oil layers, and the consequent readiness of the oil to escape through any crevice, does not readily appeal to one. A pillow-block cover, if kept slack when the stress on the journal is severe sideways, will readily allow the oil to escape at the parting, or at least so much as to cause wear of the bushes. An instance of the value of leading oil into a bearing is seen in the following case:—A journal 10in. by 10in. was supported on a pad 3$\frac{1}{2}$in. broad, and was kept in position by side pads. The pressures ranged apparently from 800 lb. to 1000 lb. per square inch. The only oil that availed to keep the journals cool was castor oil. New pads were made of the same size, but with a circular shelf of about 2in. broad clear of the bearing at the outer edge, so as to lead the oil through a gentle inclination into the bearing surface. The bearing gave no trouble afterwards with ordinary machine oil. The entering side of the pad which was removed was $\frac{1}{4}$in. thinner than the off side. The revolution of the journal tended to move out the pad from below it, giving extra wear at the entering side. It is suggested that when the lower part of a four section bush is shallow, and is allowed freedom of movement, the same action is induced, to the detriment of the lubrication.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

A QUIET tone characterises business, and new orders are deferred until after the close of the quarter. German and Belgian competition has re-appeared, joists being offered at as low as £4 10s., and No. 2 iron bars at only 1s. or 1s. 6d. over £5. At such cutting prices it is difficult for local manufacturers to make headway. Main sheets are quoted:—Singles, £7 2s. 6d. to £7 5s.; doubles, £7 5s. to £7 7s. 6d.; trebles, £7 17s. 6d. to £8; which quotations are about 2s. 6d. less than those of a few weeks ago. Galvanised corrugated sheets are £11 5s. to £11 10s., f.o.b. Liverpool. Some of the best iron houses are well off for work. Marked bars are quoted £8 10s.; L.W.R.O. brand, £9 2s. 6d.; second grade, £7 10s.; and common unmarked, £6 5s. to £6 10s. Pig iron appears to be giving way as regards some of the second and third-class qualities. Users of ordinary Northampton descriptions are trying to renew supplies at from 47s. to 48s., but sellers declare that no profit is obtainable at such figures, and they are holding out for at least 6d. more. Staffordshire cinder pig iron is quoted 48s. to 49s.; part-mine, 49s. to 50s.; all-mine ordinary, 60s. to 67s. 6d.; best, 80s. to 85s.; cold blast, 95s. to 100s.

Steel makers are fairly well engaged, but complain of competition. They quote angles £5 15s. to £6 7s. 6d.; girders, £6 to £6 5s.; and plates, £6 5s. to £7.

The engineering trades are well employed, and some of the electrical machinery firms are increasing their staffs. Weighing machinery is in large request. Messrs. W. and T. Avery have declared a dividend at the rate of 5 per cent. per annum on the preference shares, and at the rate of 15 per cent. per annum on the preference shares, which will make the total distribution on the ordinary capital 10 per cent. for the year. A satisfactory year has been experienced by Kynochs. In addition to other extensions and developments, two firms, known as the Oilmill and Reedham, adjoining the company's Kynochtown factory, and containing in all 230 acres, have been purchased during the year. The gas and oil engine business of the Forward Engineering Company has been taken over by Kynochs by agreement, and the manufacture is in process of removal to the company's works at Holford. The military ammunition trade has been very slack during the year. It has been necessary to discharge a very large number of workpeople, and great difficulty has been found in finding profitable employment for those who remain.

Some large orders are held in the railway wagon and carriage building trade, both on home and foreign account, and the works present a scene of very cheerful activity. The contracts under execution are for various countries, including India, South Africa, and the Far East.

A new sewerage engineering scheme, at a total estimated cost of £82,238, has been wisely decided upon by the Yardley Rural District Council, who have found that the population is quite outgrowing the present sewerage facilities, and who evidently recognise the importance of good sanitation from the point of view of the public health. The scheme involves the laying down of 17 miles of sewers to deal with the present and future population for thirty years. It is anticipated that at the end of that period Yardley's population will be 100,000, and that the Council will have to deal with 7,200,000 gallons of drainage per twenty-four hours. When the extensions are carried out the town will have a very good system of drainage and bacteria works.

NOTES FROM LANCASHIRE.

(From our own Correspondent.)

MUCH the same dragging sort of trade that I have reported for some time past still represents the situation in the iron and steel market, and to a large extent throughout the engineering industries. I may add that I hear rumours of a large order for engineering works equipments having gone to the United States, and that English firms have recently, in meeting continental competition, had to accept "German terms"—whatever these may be, but which I am informed are the reverse of satisfactory—to secure orders. For the most part well-equipped up-to-date engineering firms are getting sufficient work to keep them fully going, but the prevailing complaint still is that new work comes forward only from hand to mouth.

Not more than a slow sort of business continues the general report on the iron market here, and although the Manchester 'Change meeting on Tuesday brought together a fair average attendance, it was exceptional where inquiries of any moment were put forward, operations continuing mainly of a merely hand to mouth character. In pig iron only a very restricted weight of buying goes on, with a more or less general weakness in prices, which are very much cut up by speculative operators for forward delivery. Lincolnshire pig iron makers at their usual fortnightly meeting, held on Friday, decided, as I anticipated last week, upon a further reduction in their list basis rates, although not to the extent which in some quarters was expected. Both foundry and forge qualities have been reduced 6d. per ton, but speculative sellers last week were underquoting in anticipation of a reduction of 1s. per ton. Some extra business has come forward at the reduced rates; there is, however, still underquoting. Derbyshire brands have been quoted very low, and Lancashire makers have had to follow to some extent the reduction in Lincolnshire. Delivered Manchester district, Lancashire makers are scarcely quoting more than about 55s.; the basis for Lincolnshire is now 50s. 6d., with, however, outside sellers at 50s., and quotations for Derbyshire range from about 54s. to 54s. 6d. up to about 55s. 6d. net. Forge qualities, delivered Warrington, are now quoted about 50s. Derbyshire, 50s. 2d. Lincolnshire, and about 50s. 3d. Lancashire. Middlesbrough iron is perhaps a trifle stronger, as compared with the minimum quotations of last week, but the average market rates are not more than 54s. 4d. and 54s. 7d., with some brands still quoted 54s. 10d. net by rail Manchester. Lower quotations are current for Scotch iron; delivered Manchester docks, Eglinton can be bought at about 57s. 9d. to 58s.; Glengarnock, 59s. 6d. to 60s.; and Gartsherrie about 61s. net.

Finished iron makers report no improvement in the position, new business still coming forward in but very small quantities, and the large forges only kept running about two-thirds time. Meetings of the Lancashire associated bar and hoop iron makers were held in Manchester on Tuesday, but no alteration was made in the list basis rates, finished iron representatives reporting that there was no probability of getting any material concession in the price of fuel whilst other costs continued exceptionally high, so that they were not in a position to come down in their selling prices. Delivered Manchester, Lancashire bars remain about £6 8s. to £6 10s.; North Staffordshire, £6 10s. to £6 15s.; sheets, about £8 to £8 2s. 6d.; and hoops, £7 2s. 6d. randem and £7 7s. 6d. special cut lengths, and 2s. 6d. less for shipment.

The situation in the steel trade remains without material change. Hematites still meet with but a limited inquiry, with makers' quotations about 66s. 6d. and 67s. up to 68s., but sellers in the open market are as low as 65s. 6d. net. Local made billets are still quoted £4 15s., although German billets are to be bought at about 5s. less. Steel bars average about £6 5s. to £6 7s. 6d., with £6 10s. quoted by some makers for small sections. Angles can be bought at about £5 10s. to £5 12s. 6d.; and common steel plates about £6 7s. 6d. to £6 10s. Boiler plates are still quoted from £7 as the non-Association to £7 2s. 6d. as the Association basis for boiler specifications delivered in the Manchester district.

Further reports which have come to hand from workmen's associations connected with the engineering and allied branches of industry are much to the same effect as those from which I gave extracts last week. The secretary of the Steam Engine Makers' Society reports a steady decrease in the number of unemployed, which is now not more than about 1$\frac{3}{4}$ per cent. of the total membership; but notwithstanding this apparent improvement in industrial conditions he scarcely has much confidence in the general outlook of trade.

The local representatives of the Amalgamated Society of Engineers in their district reports state that in the neighbourhood surrounding Manchester the improvement in the unemployed list has been more than maintained, the members signing the vacant book showing a further substantial decrease compared with last month, and there is still a demand for smiths and patternmakers.

A further unsuccessful effort has been made to get the working hours on the night shift at the Westinghouse Company, Trafford Park, re-arranged so as to make the stopping time more convenient for the men getting conveyance to their homes by altering the starting time to 8 o'clock in the evening, instead of 5.30. A deputation of the workmen, at the instance of the District Committee, had approached the management on the subject, but the reason for non-compliance with the request was that the night men could not get in touch with their day mates if the hours were altered as desired. Other matters, including demarcation of work, the one break, overtime conditions in regard to piece-work, wages, &c., were subjects still in the hands of the District Committee awaiting developments.

In the Liverpool district it is also stated that it is gratifying to report what seemed to be a decided improvement in the majority of the districts comprising the division, as, with one or two exceptions, the number of unemployed was steadily decreasing, and even in those districts referred to where it could not be said things are so bright, a substantial reduction was shown. The most marked improvement was shown by the Liverpool district, where the number signing the vacant books of the various branches was reduced, as per the April and May reports, by about one-half, whilst at Blackburn, Bolton, Bury, Preston, Rochdale, &c., where trade might be described as fairly moderate, more members were employed. The same might apply to Oldham, although it could not be said matters were in a very flourishing state there just at present. It was pleasing to say, however, that the great railway centres, Crewe and Horwich, were busier than ever, the latter place having recovered from the temporary falling off which occurred towards the end of last year, and a most striking fact was that these two centres of the locomotive industry, with 1800 members, hardly ever returned members on the out-of-work list.

The general secretary of the British Steel Smelters' Association reports as to the condition of trade in the above industry that neither in the steel trade nor yet in the tin-plate trade is the outlook of a satisfactory character. There was no appreciable change since last month with respect to the volume of employment, and there did not seem to be any prospect of improvement as regards prices, or in the volume of trade. Several employers had stated that Mr. Chamberlain's "Zollverein Balloon" was likely to injure rather than improve trade, as the tendency was to unsettle buyers and sellers. With regard to the financial position of the society, he is, however, able to report that this is exceptionally favourable, the finances showing a very substantial gain over those of last month.

The half-yearly meeting of the Manchester Association of Engineers was held on Saturday, Mr. E. G. Constantine, president, in the chair. The business, which was mainly of a formal character, included the election of five members of the council for the ensuing year, for which there had been ten nominations, and the election of five new members who had been nominated since the previous meeting. The following were elected members of the council:—Messrs. Robert Matthews, Sir W. G. Armstrong, Whitworth and Co., Manchester; George Kiernan, Gresham and Craven, Limited, Manchester; William Taylor, Buckley and Taylor, Oldham; Arthur Walsh, Musgrave and Son, Bolton; J. Atkinson, Crossley Bros., Limited, Manchester. The following were elected members of the society:—W. H. Bunch, Empire Engineering Company, Failsworth; J. Crawford, Davidson and Co., Limited, Manchester; G. W. Lawton, Bradbury and Co., Oldham; H. Roberts, Roberts Bros., Dukinfield; G. K. Vickers, Craven Bros., Reddish. It may be added that arrangements have been made by the council for a visit to Coventry on Monday next, when the members will have the privilege of inspecting the works of Messrs. Alfred Herbert, Limited, The Daimler Motor Company, Limited, and The Motor Manufacturing Company, Limited.

New works have just been built at Leigh, near Manchester, and equipped with special plant by Messrs. Sutcliffe, Speakman and Co., Limited, for the construction of a patented plant and machinery for the manufacture of building bricks and concrete paving flags from blast furnace slag, coal shale, gasworks clinker, and other waste products by an improved process. This process includes in the first place a special preparation of the material, which is mixed in a steam-heated mixer in such a way that all the materials are thoroughly heated and moistened by steam, while an edge runner kneads and tempers the material. By this arrangement it is claimed that concrete flags can be made ready for use in three days and have a strength exceeding that of granite. With regard to building bricks these are made by patented machinery, one special feature of which is an attachment which gives each brick two pressings, the first squeezing and pressing the material from the centre into the corners and arrisses, whilst the second pressure finishes the brick and renders it of even density throughout with fine, sharp corners.

Only a very indifferent sort of trade is the general report throughout the coal trade of this district, and pits for the most part are getting on to about four days per week; in some cases they have been working even less than this. For all descriptions of fuel there is only a very restricted inquiry, and with plentiful supplies offering. Prices, although without quotable change, tend towards weakness, especially for prompt clearance sales, where surplus quantities have to be moved away. There is, however, a firmness in holding to late rates on contracts, and large users are finding it very difficult to secure forward supplies at anything materially under current rates.

The better qualities of round coal continue in very slow request for house-fire purposes, and on special sales there is some irregularity in prices, but the general pit rates remain without quotable change. With the continued not very satisfactory condition of the iron and other large coal-using industries there is

but a moderate sort of inquiry for the lower qualities of round coal suitable for steam and forge purposes. The quietude in the house-fire coal trade necessarily tends to throw a good deal of common round coal on the market, and this causes supplies for steam and forge purposes to be plentiful, with the result that here and there prices are cut low to effect prompt clearance sales; these low figures are, however, not being accepted where buyers wish to contract forward. Generally, the quoted rates remain much the same as have been ruling for some time past, and it is only in special cases where there is any material giving way upon these, ordinary steam coals remaining about 8s. 3d. up to 8s. 9d. per ton, according to quality, at the pit.

All descriptions of slack continue in rather slow demand, and with production ample to meet requirements, prices are not more than maintained at late rates, whilst there is a good deal of competition with cheap surplus lots coming in from other districts. For best slack quotations are still about 6s. 3d. and 6s. 6d. up to 7s.; medium sorts, 5s. 3d. and 5s. 6d. to 5s. 9d.; and common sorts, 4s. 3d. to 4s. 6d. and 4s. 9d. per ton at the pit.

Not more than a moderate business is being put through for shipment, and there are some very low-cut prices to effect special sales, but the general quoted rates remain much the same as have been given of late.

The requirements for all descriptions of coke are being kept up in excess of production, and as contracts run out makers are stiffening in their prices for renewals.

Barrow.—There is a firm tone in the hematite pig iron trade, and business is improving. The make is kept low, comparatively, only 33 furnaces being in blast, compared with 36 in the corresponding week of last year, but it is satisfactory to find that the scarcity of iron is resulting in a further decrease in stocks, the clearance this week having been 1492 tons, leaving still in stock 18,844 tons, or a reduction of 5459 tons since the beginning of the year. Makers quote the old figure of 59s. 6d. for mixed Bessemer numbers net f.o.b. Warrant iron is at 57s. 9d. net cash sellers, 3d. less buyers. Several shipments of iron are being made to America. Forge and foundry iron is quiet. Spiegeleisen is in good demand, and one furnace is kept constantly on the production of this metal.

Iron ore is busy, good sorts find ready sales, and even inferior sorts find a market, as they are mixed with advantage with Spanish ores, which are being liberally imported and used at West Coast furnaces. Native sorts are at 12s. for good ordinary, and at 16s. for best net at mines. Spanish ores of good quality are at 16s. 6d. per ton net at West Coast ports.

The steel trade remains well employed on heavy rail sections, and a steady business is being done in light sections and in tram rails, although the tram rails for the Barrow tramways, which are being put down by the British Electric Traction Company, are being imported from Belgium. Heavy rails are at £5 5s. to £5 10s. per ton. There is a better inquiry for steel plates for shipbuilding and boiler-making purposes, but the mills at Barrow are only working half time. The local demand for shipbuilding material is quiet. Business in hoops is slow, and the heavy steel foundries are not fully employed. Other classes of steel, however, are in steady demand, and prices, generally speaking, are firm.

Shipbuilders have not booked any new orders, but tenders are being prepared for several vessels which are to be built in the early future, and it is expected that Admiralty work will soon come to hand. The first of two Channel steamers, the Colleen Bawn, building at Barrow for the Lancashire and Yorkshire Railway Company for the Fleetwood and Drogheda service, was launched at Barrow last week.

During last week the shipments of iron reached 13,837 tons, and steel 10,195 tons, as compared with 10,811 tons of iron and 11,550 tons of steel, an increase in iron of 3026 tons, and in steel a decline of 1355 tons. The shipments of iron this year stand now at 192,171 tons, and steel 266,807 tons, as compared with 189,918 tons of iron and 247,818 tons of steel, an increase of 2253 tons in iron, and an increase of 18,989 tons in steel.

The coal and coke trades remain weak. The demand is slow, and prices do not improve. Steam coal are in smaller consumption, and the domestic demand is very quiet.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THERE is a perceptible falling off in the demand for coal, more especially in household sorts, and prices are steadily drooping. At the same time, ordinary consumers are not obtaining any benefit, although we have now got beyond the middle of June. A sharp touch of cold weather, succeeded by a three days' rain, has helped consumption somewhat, but it is too far on in the season for any wave of cold to greatly affect values. Coal buyers are objecting to pay more than 10s. 6d. or 11s. per ton, and at several of the collieries stocks are observed to be increasing.

In steam coal, however, sales are easily effected, the railway companies having very heavy deliveries, while the trade to the Humber ports is quite up to the average, the Baltic requirements being more than usual. Values consequently remain firm, all coal bought in the open market being easily disposed of at 3d. to 9d. per ton more than the contract price of 9s. per ton.

Gas coal contracts are proceeding somewhat slowly, the large consuming companies evidently anticipating easier rates, and thus being induced to hold their orders in suspense. In coke, ordinary foundry samples are fetching an average price of about 10s. 6d. per ton, better samples going up to 12s. and 12s. 6d., and best washed up to 13s. Rather less is doing in slack and small coal, owing to the demands for the Lancashire cotton mills having decreased considerably. For the better qualities values are fairly maintained.

In the East End the military material establishments are waiting for the passing of the Budget resolutions, following which will come the orders for armour under the new Admiralty scheme. Tenders for further armour were sent in some time ago, but it is not expected that anything definite will be known until the Admiralty programme has been definitely settled by the passing of the resolutions. Such orders, however, as are embraced in that scheme are not of any great importance, although they will be none the less welcome, as the work now in hand is pretty well completed.

In the House of Commons, on the 16th inst., Mr. James F. Hope, the member for Brightside—where the leading Sheffield establishments are located—interrogated the Secretary to the Admiralty on this subject. The Secretary, Mr. H. O. Arnold-Forster, replied that all the necessary steps are being taken with a view to placing the orders, as nearly as possible, at the times arranged for on the Admiralty programme, in order to earn the money voted before the end of the financial year. In the forging departments the outlook is not particularly hopeful, as the Admiralty are not likely to place any new ships in the present state of the country's finance, while the freight market does not encourage the laying down of merchant vessels. Castings and forgings, therefore, are in very poor request, with no bright prospect in the near future.

The directors of John Brown and Company, Atlas Steel and Ironworks, Sheffield, have this week issued their report for the year ended March 31st, 1903. They state that the general depression of trade referred to in last year's report has continued throughout the twelve months, and the earning powers of many of the departments of the Atlas Works have been consequently affected. The armour plate department has been partially employed only during the last year, and the orders now in hand are being rapidly completed. The directors express the hope that further orders will shortly be received. Good progress has been made at Clydebank on the first-class cruiser Antrim, and also on the large battleship Hindustan, for the Admiralty. Recently an order has been received for a steamer for the Cunard Steamship Company, and the directors anticipate that the yard will be fairly well employed during the present year. It is interesting to note that the directors describe the coal trade of the district during the year as having been much depressed. They add that it has been impossible to make any reduction of costs in production to meet the low prices of coal which now prevail.

In the iron trade quotations do not move, and are not likely to be changed for some time, unless unexpected developments take place. Quotations, which we give below, do not show much variation from those current for several weeks past:—West Coast hematites, 69s. 6d. to 70s.; East Coast hematites, 64s.; Lincolnshire forge iron, 48s.; Lincolnshire foundry, 49s.; Derbyshire forge, 48s. 6d.; Derbyshire foundry, 51s. to 51s. 6d.; common bar iron, £6 10s.; hoops, £7 2s. 6d.; Bessemer billets, £7 15s.; Siemens-Martin billets, £7 5s.; steel hoops, £7 10s.

Much disappointment is expressed in the railway material departments, the orders which it was expected would have been placed some time ago being still withheld. The home railway companies seem determined to do no more than is necessary for day-to-day requirements, with the result that plant employed in railway specialities is by no means fully engaged. South African and Indian demands are more satisfactory, but even here a great deal more work could be done. The lack of activity in the railway branches has its usual effect in depressing the Siemens and Bessemer steel departments, the work given to the hands being consequently insufficient to keep them fully engaged.

The lighter staple trades of the city have improved somewhat since the holidays. Several of our old-established cutlery firms report that they have recently received satisfactory orders, though even in their case they could do a great deal more work, and would be glad to have it.

NORTH OF ENGLAND.

(From our own Correspondent.)

IN several respects the iron market in this district now shows satisfactory improvement; the tone this week is more sanguine than it has been for a long time; shipments are remarkably good, almost the best on record; stocks in the public stores are being drawn upon rather heavily; makers' stocks have well nigh disappeared; and deliveries are in excess of production. The position for makers of pig iron is acknowledged to be a sound and healthy one, and the opinion is that prices are much more likely to advance than to recede during the next half year. The news from America has become somewhat more optimistic in character, but it does not lead to the expectation that there will be a revival of the demand for Cleveland iron by American consumers. The latter are able to get all they require from home works, and at prices below those at which Cleveland iron can be supplied to them. From what can be seen, however, there is not likely to be any surplus production of American iron this year, and thus it will not be necessary for makers of the latter to "dump" any down in European markets, so that it will not come into competition on this side or in neutral markets with our own iron. It is not usual for the American producer to accumulate large stocks of pig iron. American consumers are sending no orders over here now, but there is still some Cleveland iron being sent to them. Two cargoes have gone this month, but is in completion of orders placed some months ago.

The home demand for Cleveland iron has improved, as has also the continental inquiry, the latter in a marked degree, especially from Germany, and this month there has been quite a rush for shipments to that country. This latter is partly due to the desire of consumers in the interior that the iron should be delivered to them before the river and canal freights are advanced, as they are every summer when the rivers run low, and the barges can only be lightly laden. Consumers in North Germany have bought rather freely of late, the Cleveland prices being such that they admit of successful competition with German iron, notwithstanding the 10s. per ton duty. It is more than a twelvemonth since the deliveries of pig iron from this district to Germany were so good as at present, and they are much better than anyone expected. Altogether the deliveries overseas are this month double those of June, 1902, though in the earlier period shipments to America were heavy. Scotland this month has taken 50 per cent. more Cleveland iron than in June last year or in June, 1901, and more would have been forthcoming. The total shipments of pig iron from Cleveland this month to 17th were 70,470 tons, against 53,140 tons last month, 40,996 tons in June, 1902, 43,620 tons in June, 1901, and 55,133 tons in June, 1900. Such good exports have served not a little to restore confidence in this market.

The returns of stock are equally satisfactory. It has been necessary, with such extensive deliveries, to draw heavily from the stock, with the result that the quantity held in makers' yards has been reduced within very narrow compass; in fact, it is affirmed on good authority that makers do not hold more than three days' output of Cleveland iron, which is less than has been known for some years. The shortness of the supply is shown by the difficulty that is frequently experienced by consumers or shippers in getting delivery of the iron they have bought. In Connal's public warrant stores the stock is being reduced. The quantity held on Wednesday was 139,864 tons; decrease this month, 3576 tons. Practically all the business on the market is now done in Cleveland warrants, there being so little Scotch and hematite—15,000 tons of the former and 21,000 tons of the latter. It does not seem likely that there will be any addition to the stock of Scotch warrants; in fact, there is some probability that the stock will disappear altogether, so that speculators are now using Cleveland warrants as counters for their operations, and Scotch are seldom even quoted.

The position of makers of Cleveland pig iron may be described as a sound one, and the market generally is this week showing more stability than for a long time; this is bringing consumers in more freely, and they are exhibiting a disposition which has long been wanting—to buy for forward delivery. But as they have been offering somewhat less for next half year than they are prepared to pay for prompt, not much actual business has resulted. Makers believe that prices will improve rather than recede during the next few months, and will not accept less for forward. No. 3 Cleveland G.M.B. pig iron has been steady all the week at 46s. 3d. per ton for early f.o.b. delivery. No. 1 is at 48s. 6d., and No. 4 foundry at 46s., but it has been almost impossible to get any of the latter, which is largely sent to Scotland. Grey forge is realising 45s.; mottled, 44s. 6d.; and white, 44s. 3d. per ton.

Makers of East Coast Newcastle hematite pig iron are doing fairly well, they have little to sell, and are realising relatively better prices than the makers of ordinary Cleveland pig iron, but they have not to compete with a large stock in the public warrant stores, there being only 300 tons in the stores in this district. Mixed numbers of hematite pig iron are sold at 57s. per ton, and No. 4 at 54s. For spiegeleisen, 20 per cent. the price is 85s. A second furnace has within the last few days been restarted by the Linthorpe and Dinsdale Smelting Co. at the Middleton Ironworks, near Darlington, to produce spiegeleisen. Rubio ore is firm at 16s. per ton c.i.f. Tees.

The manufactured iron and steel industries of this district are dull, with the exception of the rail trade. But makers do not reduce their quotations—they cannot very well afford to do so; and if they reduce they do not think orders would flow in more freely. Heavy steel rails are quoted at £5 10s. net at works. Steel ship-plates are at £6, steel boiler plates at £7 5s.; iron ship-plates at £6 15s.; steel sheets at £8 10s.; steel ship angles at £5 10s.; iron ship angles at £6 7s. 6d., and common iron bars at £6 10s., all less 2½ per cent. f.o.t. Messrs. Dunford and Elliot, of Newcastle-on-Tyne, Middlesbrough and Sheffield, will establish works at Darlington for the manufacture of their patent rope and plough wire. The new works will be at Albert Hill, on the site of the old Skerne Ironworks, latterly occupied by the Standard Wire Company's establishment.

While the marine engineering industry is rather slack the general engineering business is in a satisfactory condition, and as a rule works are kept fully going. This may be said also of the bridge-building establishments. The Cleveland Bridge and Engineering Company, Limited, Darlington, which has in hand the new high-level bridge over the Tyne for the North-Eastern Railway Company at Newcastle, has secured the contract for the erection of a bridge in connection with the Cape to Cairo railway. It is for the British South Africa Company Railway, and for the order there competed six firms—American, German, and English. The bridge, which will be 700ft. long, the main arch being 500ft., will span the river Zambesi close to the Victoria Falls, and the floor of the bridge will be 400ft. above the bed of the river. The structure is intended to carry a double line of rails, and the construction will be carried out without staging. On Sunday last the company placed in position the girders, each weighing 170 tons, for strengthening the bridge over the river Trent at Gainsborough. The company are doubling the capacity of their works at Darlington, and have nearly completed a new main machine shop, 100ft. wide and 700ft. long. Nearly the whole area of the works is being roofed in, and work can be carried on in all kinds of weather. Messrs. Worth and Mackenzie, Limited, are about to extend their Phœnix Works, at Stockton-on-Tees; and Messrs. Ropner and Sons are erecting a new fitting shop and an iron store at their North Shore Shipyard, Stockton.

Alderman John Frederick Wilson, J.P., of the Tees Ironworks, Middlesbrough, has presented to the Middlesbrough Exchange Company, Limited, a valuable and interesting document, which the latter have hung in the Exchange Hall. It is a plan, published in 1822, of the proposed Stockton and Darlington Railway, drawn up when the promoters applied to Parliament for powers to construct the line—the first passenger railway in the world, which was opened on September 27th, 1825. The map is entitled, "Plan and Sections of the Intended Railway or Tramroad from Stockton by Darlington to the Collieries near West Auckland, in the County of Durham, and several branches therefrom and variations and alterations, 1822." The branches were to Croft, Yarm, Black Boy Colliery, &c. A list of the owners of the properties through which the line would run is enumerated, and the portions taken from each is defined and coloured on the map.

The coal trade continues active, and prospects are, on the whole, very satisfactory. Thus prices are well maintained, and sellers are not prepared to sell forward at prices below those which rule for early delivery. There is little either steam or gas coal now available for sale for July shipment. For best steam coal not less than 10s. 9d. per ton f.o.b. will be taken, seconds are at 9s., and small at 5s. 9d. The Northumberland collieries are specially well off for work. A conference is shortly to be held between the Northumberland Coalowners' Association and the delegates of the miners to consider the question of the hours and wages of men working coal-cutting machinery, and it is expected that a proper arrangement will be arrived at. Best gas coals are quoted at 9s. per ton f.o.b. The Newcastle and Gateshead Gas Company has contracted with several Durham collieries for 280,000 tons of gas coal to be delivered over the next twelve months, and the prices taken range from 8s. 3d. to 8s. 6d. per ton delivered at the company's works, that being about 4d. less than the prices paid for the last twelve months' supply. The South Shields Gas Company also require 45,000 tons of coal, delivery over the next twelve months. Medium coke delivered at the Middlesbrough blast furnaces is still at 16s. 3d. per ton, but some has been sold at 16s. Foundry coke is at 17s. 6d. per ton f.o.b.

The death took place on Saturday of one of the best known mining engineers in the county of Durham, Mr. Cornelius William Martin, head viewer of the Newbottle group of the Lambton Collieries and North Biddick, Lumley, and Harraton pits. He was forty-five years of age, and up to 1893 was manager of Murton Colliery. The Lambton Collieries, Limited, for whom he was manager, employ about 20,000 men and boys. He was greatly esteemed, and will be much missed, as any movement of the workpeople obtained his ready sympathy.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Scotch iron trade has been quiet this week in all its departments. A fair amount of work is in hand, and there is little idleness observable at the works, but complaints are general that fresh orders are difficult to obtain.

The Glasgow warrant market opened with some appearance of strength on Monday, and prices of warrants went up a few pence per ton. The improvement was, however, subsequently lost. The quantity of iron changing hands is comparatively small, and business is almost altogether confined to Cleveland warrants.

Scotch warrants, which were quoted 53s. at the beginning of the week, have since been sold at 53s. 6d. for cash. Business has been done in Cleveland warrants from 46s. 4d. to 46s. cash, at 46s. 1d. and 46s. 0½d. for delivery in six days, and 46s. 7d. to 46s. 3d. one month. Cumberland hematite is quoted nominally 57s. 9d., both for cash in one month.

The demand for pig iron on the part of home consumers has been limited, as regards Scotch iron especially. Cleveland iron is more wanted for foundry and forge purposes, and in it by far the larger business is being done with the makers of manufactured goods.

The prices of Scotch makers' iron are fairly steady. Wishaw, No. 1, is quoted at Glasgow, 55s.; No. 3, 51s. 6d.; Carnbroe, No. 1, 57s. 6d.; No. 3, not quoted; Clyde, No. 1, 63s.; No. 3, 57s. Gartsherrie, No. 1, 63s. 6d.; No. 3, 57s. 6d.; Calder, No. 1, 63s.; No. 3, not quoted; Summerlee, No. 1, 69s.; No. 3, 58s. 6d.; Langloan, No. 1, 70s. 6d.; No. 3, 59s. 6d.; Coltness, No. 1, 72s. 6d.; No. 3, 59s.; Glengarnock at Ardrossan, No. 1, 63s. 6d.; No. 3, 57s. 6d.; Eglinton at Ardrossan or Troon and Dalmellington at Ayr, No. 1, 57s. 6d.; No. 3, 54s.; Shotts at Leith, No. 1, 66s. 6d.; No. 3, 58s. 6d.; Carron at Grangemouth, No. 1, 67s.; No. 3, 58s. 6d. per ton.

A steady inquiry exists for Scotch hematite, which is quoted by merchants 61s. 6d. per ton for delivery at the West of Scotland steelworks.

Since last report the stock of pig iron in Glasgow warrant stores has been reduced by about 250 tons. The total reduction since the beginning of the year has been 8700 tons, and the total stock at the time of writing amounts to 15,300 tons.

There are 82 furnaces in blast in Scotland compared with 86 at this time last year, and of the total 43 are making hematite, 33 ordinary, and 6 basic iron. The shipments of pig iron from Scottish ports in the past week were lighter than usual, amounting to 5312 tons, compared with 6731 in the corresponding week, showing a decrease of 1419 tons. The total shipments since January 1st are 162,839 tons, against 140,211 in the corresponding period of 1902, showing an increase of 22,628 tons.

The arrivals of Middlesbrough pigs at Grangemouth during the past week reached 12,199 tons against 11,282 in the corresponding week, showing an increase of 917 tons. The total imports of this class of iron for the present year to date amount to 265,336 tons, being 23,890 tons more than in the same period of last year.

The finished iron and steel branches do not call for any very special notice. Work is proceeding steadily in most instances, but complaints are general as to a scarcity of orders. This refers specially to the malleable iron branch of the trade. A few new orders are dropping in in the shipbuilding branch, but work is generally scarce, and competition has run prices down to the point where profit vanishes, so that there is altogether a feeling of depression in the trade.

Ironfounders are in a number of cases well supplied with work. Those engaged in the manufacture of domestic utensils are doing better than for some time, the demand for export having materially improved.

The locomotive engineering works are in almost every case very busy, and some of them are regularly working night shifts so as to be able to finish the contracts within a specified time.

The executive of the Associated Society of Engineers has thrown

something like a bomb into the midst of the branches on the Clyde by demanding that the money which was paid by local officials in the name of strike allowance during the recent dispute should be refunded. There was no doubt that the strike was contrary to the advice of the chief union officials. The local officials a lege that the ballots to decide the matter were taken at the instance of the executive officers, and that in both cases they were in favour of a strike. The dispute still goes on, and some even hint that it may lead to a disruption in the society.

There has been a fair business in the coal trade during the past week. The household demand for home use has been very much better than usual owing to colder weather, and this has helped to maintain prices in this branch of the trade. The shipments are in the aggregate considerably smaller than in the preceding week. There was a marked falling off at western ports, but a sharp improvement in Fife has to a considerable extent made up for this. On the south side of the Firth of Forth business has been quiet, but vessels coming to hand give promise of better shipments in succeeding weeks.

The question of a reduction of colliers' wages, after being debated by the Conciliation Board in private, has been referred to Sheriff Jameson, the arbiter, for final settlement.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE unseasonable weather has had a bad effect on everything industrial, hampering work, colliers, business at ports, railway arrangements, quite setting back the excursion tide. I have noticed over a wide stretch of country in South and Mid-Wales the last-named grievance, and note that many railways will suffer in their next dividends. But it is at the Welsh ports where the weather is having an injurious influence. A few weeks ago the outlook of the steam coal trade was hopeful; this week there is a certain amount of depression, especially on 'Change at Cardiff. This is due to delayed tonnage. Coalowners are well sold for a month, or even two ahead, so the difficulty may be regarded as only one of a temporary character, which a few days will correct The trade barometer is a very sensitive one, and I am afraid that its changes lead to "bearing" when not justified by the general character of trade.

This week it was evident that buyers were able to secure quantities of coal of the best character at figures below last week's quotations. These quotations remain, and probably next week will be firmer. Small steam, house coals, dry, and Monmouthshire are all slightly depressed. Latest quotations are:—Best steam, 14s. 9d. to 15s.; seconds, 13s. 6d. to 14s. 3d.; drys, 12s. 3d. to 12s. 9d.; best steam small, 7s. 9d. to 8s., other qualities are obtainable from 6s. 9d., while best seconds are quoted up to 7s. 6d. Best Monmouthshire is at 13s. 6d., best ordinaries from 13s. House coal, only nominal figures remain at all prices from 14s. 6d. to 16s., best Rhondda from 14s. 6d.

At Newport figures were easy. Very best Monmouthshire, 13s. 3d. to 13s. 6d. At Swansea a tolerably satisfactory market characterised the anthracite trade, though some qualities were easier. Large coal from 13s. 3d.; red vein from 10s 6d. Paris, French and German nuts, quite a new item in nomenclature, 21s. 6d.; culm from 6s. 6d., which just comes under tax.

Best steam is selling at Swansea for 14s. 9d.; seconds down to 12s.; bunkers at 9s. 6d. to 10s.; small, 6s.; house coal, 14s. 6d.; patent fuel from 13s. 6d. This trade is more buoyant, nearly 15,000 tons going to foreign destinations last week.

All coal quotations are subject to thirty days cash, less 2½.

Pitwood, Cardiff, and Newport, still weak; ordinary quotations, 16s. 6d. No prospect of improvement until weather changes to a more settled condition, for though arrivals are less from Ireland, Spain, and France, coalowners' requirements are less.

Cardiff is shipping fuel much more freely. 3600 tons went to Rio this week. During a slight break in the weather this week, some good coal shipments were despatched from Cardiff, 10,500 tons going to Port Said, 4500 to Madeira, and several large cargoes to France, Alexandria, and Constantinople, and Monte Video.

I hear that the two authorities in connection with the Government Commission on our coal supplies of Wales will be Sir W. T. Lewis and Mr. Morgan W. Davies, M.E., Swansea.

Several important mineral properties are in the market, and will be brought to the hammer this month. At the Tynewydd and Aber Rhondda Colliery the fixed and loose plant will be submitted to auction next week. This is one of the old collieries of the Rhondda Valley with a striking history, it being the scene of the famous inundation and rescue of the few survivors. On that occasion the Lord Mayor of London journeyed to the district to bestow decorative medals for valour. One of the last of the rescuers, William Thomas, M.E., Brynawll, only died lately at the age of 70.

The largest steam tug afloat came to Cardiff this week. This is the Roland, a German vessel. Her engines are 1500 horse-power, and the machinery of the latest. She is fitted with Marconi appliances, and will take away in bunkers 500 tons coal.

The steel trade is fairly active, and tin bars, as well as steel rails, are quite up to the average. Last week there was a large consignment of rails sent from Dowlais to India *viâ* Cardiff, which was commented upon at the port as a very fine sample of heavy sections. They were sent by Rhymney Railway, which is now well occupied in running up iron ore to Dowlais. A fair sign of the iron and steel industries being in brisk condition is the animation in coke, which is prompting restarts. One is stated to be on the eve of taking place at Briton Ferry, where the Cambrian Coke Works have been idle for a length of time. This, when started, will employ a large number of men. Coke manufacturers are realising fair prices; latest at Cardiff are 17s. 6d. to 18s. for furnace; good foundry, 19s. 6d. to 20s.; and the best, 24s. to 24s. 6d. Swansea reports substantial improvement in steel-producing departments. In tin-plate action is still partial, for which a good deal is visible at Swansea; there is some degree of slackness in other quarters, notably Llanelly, where closing down of several works is threatened, unless an improvement sets in. Steel workers are better off. In the Swansea Valley there is an improvement of late, since the holidays, in respect of several of the works: Duffryn, Morristown, Aber, Midland, Upper Forest, Worcester, Clydach, Pontardawe, and others are busy. Some of the Beaufort mills, and the Cardonnel are idle temporarily. Alterations are going on at Cwmfelin, Cwmbwela, and Clydach. At the last-named four new mills are nearly complete, and are equipped with latest plant. The character of trade is well indicated by the week's returns, over 81,000 boxes having been despatched, while the receipt from works was 74,586 boxes. This week, again, I see that great shipments are going away, the Brooklyn City taking 1000 tons, and several vessels are loading heavily for Copenhagen and Amsterdam. A comment on 'Change is that an 8000 tonner will be cleared from Swansea next week for China.

Mannesman new wage arrangement with shearers is to be carried out for two months. Spelter works are all busy. Margam new works are reported to be likely to come eventually in connection with Messrs. Byass and Co., but not at the start.

The trend of the tin-plate trade is shown by May exports. Russia took 5098 tons, slightly less quantity than that of the previous month; Germany, 1688 tons, as against 1006; Holland, 1829, against 1650; Belgium, 1866, against 753; France, 1703, against 1290; a few other countries, and the United States, less. In all, the despatch was 18,803 tons, as compared with 20,218 tons in April. Prices remain. It was stated on 'Change mid-week that buyers were pressing for concessions, which were firmly refused. The iron and steel trades were regarded as fairly hopeful, and prices were tending upwards, but remain at present the same as last week. Sheet iron and steel are at the same figures, £7 10s. to £8. Pig iron market firmer. Glasgow warrants are at 52s. 9d., large quantities coming in from Harrington and Ulverston. Freight market, Cardiff, inactive. Mediterranean are at last figures; a few satisfactory fixtures making France and Cronstadt.

In respect of railway traffic, Port Talbot is showing an increase, Rhondda and Swansea Bay and Taff Vale a decrease.

B. T. Crawshay, a descendant of the Treforest Crawshay, has left Cyfarthfa for Treforest. This was taken as an occasion for the presentation of a valuable testimonial.

Manganese ore is coming to Newport from Bombay, also consignments to Pyle and Blaina from the same quarter, which usually receives supplies from Poti.

Ebbw vale receipts of ore from Bilbao this week have been large. Prices remain, the best Almeria is quoted up to 14s. 9d., Tafna to 15s. 6d. at Newport or Cardiff.

The Rhymney house colliers are again at work.

The death of Mr. Wilkinson has caused general regret in the district, where he was much respected. Personally he was not so well known as Mr. Lambert or Mr. Grierson, but this was due more to the infrequency of his visits.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE tone last week on the iron market over here was quiet and perhaps a shade less firm than before. In Silesia crude iron was slightly depressed and a falling off can be noticed in the demand for merchant iron. Quotations for pig iron remain the same as previously, foundry pig being sold at M. 62 p.t. for local consumption, and M. 56 to M. 58 p.t. for export; hematite stands at M. 78 p.t. free at works.

With regard to employment and demand in the manufactured iron department fair accounts have, generally, been received, the position throughout being pretty satisfactory. The rail and girder mills are in specially good occupation, for both home and foreign consumption is lively. Heavy plates move off regularly, and the sheet trade has shown symptoms of improvement, export orders having realised somewhat higher prices lately.

There is little or no change to note in the state of affairs on the Rhenish-Westphalian iron market. Production of pig iron increases, and the tone is firm. Also in malleable iron a strong tendency is perceptible, and the various branches of the finished iron industry continue regularly occupied. Of course, there are exceptions, and some shops are decidedly hard up for work, while others report themselves fully engaged; but, on the whole, both home and foreign inquiry for finished iron may be considered satisfactory, with prices tending upwards.

A slow but steady improvement can be felt in the plate and sheet trade, and bars, too, are in good call.

A few days ago a Rhenish-Westphalian blast furnace works sold 25,000 t. basic to Belgium, to be delivered within the period from July 1st of present year till June 30th next year. The Belgian works is trying to place further orders for 25,000 t., for delivery in the same period, with German works, as from Longwy and Luxemburg no suitable offers could be obtained.

The iron and steel works Hoesch, of Dortmund, is building a new bar mill, with electric power.

The forty-fourth general meeting of the Union of German Engineers will take place on the 30th inst., and on the 1st and 2nd of July of present year, in München and Augburg.

Business in iron and steel in Austria-Hungary is as quiet as during previous weeks; both in crude iron and in finished articles a very limited demand only comes in. The Union of Austrian bar mills sold, in April of present year, 180,000 q., or 60,000 q. less than in the same month the year before. A so in heavy plates only 30,000 q. have been sold in April this year, against 38,000 q. in the corresponding month last year.

From an annual report given of the business in iron and steel, and machines, to Roumania in 1902, it appears that on the whole 1,139,027 kilos. were imported, Austria sending 125,089 kilos., Belgium 339,491 kilos., Germany 261,241 kilos., England 362,774 kilos., France 20,372 kilos., Greece 1250 kilos., Holland 92,521 kilos., Italy 11,775 kilos., and Turkey 49,514 kilos. Plates are chiefly imported from England.

The iron and steel trade in France does not show any change since last week, only a moderate business being generally transacted, except in the Haute Marne, where a rise in demand and increasing stiffness in quotations could be noticed; in the Nord the works are only kept going moderately, and in the centre a lack of fresh orders is very keenly felt and complained of.

There is a very good demand for coal in France, especially in the Nord and Pas de Calais. In the centre consumption is limited, and to prevent stocks from accumulating too heavily the working hours had to be restricted.

The Belgian iron market has been extraordinarily quiet during this week and the last, only in rails a good business is being done at fair quotations, and several heavy contracts have quite recently been placed, one for 1200 tons. Owing to want of orders the market for heavy plates has been decidedly dull. Quotations remain unaltered.

Rumours are afloat regarding the uniting of several iron companies in Belgium, principally of the Liège district.

As at recent tenderings for the supply of coal for the State railways, prices for coal have shown a slight decrease against previous months, owing to pressing offers, the tone of the Belgian coal market has been somewhat languid and depressed, the more so because a rise in quotations against previous tenderings was generally anticipated.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, June 10th.

THE large purchase of Bessemer pig of the United States Steel Corporation, aggregating 105,000 tons, has been followed by improving market conditions, though without very heavy orders. Of this amount 90,000 tons are to be delivered during the third quarter of the year. Large purchases of ferro-manganese are about to be made at the present price, 50 dols. per ton for 80 per cent. The crude iron market is without any particular activity just at present, but it is only a question of time when very heavy buying will result, in order to compensate for the steady depletion of stocks in progress. Consumers appear to be deeply impressed with the belief that by withholding their requirements makers of pig iron will be induced to name lower prices. There appears to be very narrow grounds for this inference. On the other hand, makers of pig iron believe that a reaction is close at hand, and that iron for steel-making purposes will show an advancing tendency early in the third quarter of the year. This fact is supported by heavy sales of basic pig at 18·50 dols. for delivery during the third quarter. All the well-established foundry furnaces are remaining out of the market, refusing to make any further concessions. Coke is now in abundant supply, and furnace production is maintained at its maximum. Bessemer billets are quoted at 39 dols. at mill, and open-hearth billets at 30 dols. Large purchases of plates for steel car work have been made by way of extension of old contracts, wherein the permission to extend contracts was specified when the original orders were placed. Large lots of Bessemer rods have sold at 37 dols., and open-hearth rods at 38 dols.; the largest order for structural material recently placed was 32,500 tons by the American Bridge Company. Strikes have in many instances caused a postponement of orders for plate and structural material. The demand for sheet iron of all kinds continues heavy. The price of steel rails is 28 dols., and a meeting will shortly be held for the purpose of taking action upon quotations for next year. Cast iron pipe makers are booking large quantities of business, and several of the larger municipalities will shortly be in the market for supplies of cast pipe, the aggregate of which, according to a recent estimate of an inside authority, was placed at 65,000 tons. The largest recent order placed by one customer for structural material was 28,000 tons to be used in the construction of two department stores. The demand for bar iron is rather slack, and prices are weaker in that branch than any other. Railroad requirements continue to attract a good deal of attention, and it is quite probable that plate, structural material, track supplies, and steel rails will be ordered very heavily during July and August, by which time there will be a confident feeling as to the permanency of quotations which may be declared by July 1st. There is a very active demand for merchant pipe, skelp iron, pipes and tubes, and other lighter material. Contracts are about to be signed for boring the shafts on each side of the Hudson River to the level of the tunnel which is to be constructed by the Pennsylvania Railroad Company. It is finally determined that the Gould system of railroads will find a terminus in this city under the influence of J. P. Morgan. Just what the conditions and terms are is a matter of speculation. The Pennsylvania Company is about beginning a series of important improvements, which will absorb the greater portion of 90,000,000 dols., which it will receive from the new 75,000,000 dols. stock loan. The gross earnings of that system this year will amount to 225,000,000 dols., an increase of 73,000,000 dols. over the year 1899. These new investments will be made in such a manner as to earn 5 per cent. Last Saturday's bank statements show that money rates will continue firm some time. The financial situation is favourable, but the holders of upwards of 500,000,000 dols. worth of unmarketable securities are in a quandary what to do with their stocks, because of the unwillingness of the public to part with their good money for fine lithographs.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal in good request, and prices firm. House coal in better demand, and prices unaltered. The quantity of coal shipped for week ending June 13th was 85,327 tons—foreign, 66,135 tons; coastwise, 19,192 tons. Imports for week ending June 16th: Iron ore, 5620 tons; manganese ore, 4500 tons; steel bars, &c., 2987 tons; pig iron, 900 tons; scrap, 180 tons; pitwood, 7560 loads.

Coal: Best steam, 13s. to 13s. 3d.; seconds, 11s. 6d. to 11s. 9d.; house coal, best, 15s; dock screenings, 7s. 6d.; colliery small, 7s. to 7s. 3d. Pig iron: Hematite warrants, 58s., f.o.b. Cumberland prompt; Middlesbrough, No. 3, 46s. 1d. Iron ore: Rubio 14s. 9d.; Tafna, 15s. 6d. Steel: Rails, heavy sections, £5 5s. to £5 10s.; light ditto, £6 5s. to £6 10s., f.o.b.; Bessemer steel tin-plate bars, £4 15s.; Siemens steel tin-plate bars, £4 17s. 6d., all delivered in the district, cash. Tin-plates: Bessemer steel, coke, 11s. 9d. to 12s.; Siemens, coke finish, 12s. to 12s. 3d. Pitwood: 16s. 3d. to 16s. 9d., ex ship. London Exchange telegrams: Copper, £57 10s. to £58; Straits tin, £129 5s. to £129 10s. Freights steady.

TRADE AND BUSINESS ANNOUNCEMENTS.

MR. BERTRAM BLOUNT, consequent on the death of his partner, has removed to 76-78, York-street, Westminster, where he will continue in practice under his own name.

WHEELER CONDENSER AND ENGINEERING COMPANY has removed from Queen Victoria-street and taken offices at Westinghouse-building, 2 and 3, Norfolk-street, Strand, W.C.

MESSRS. T. S. MCINNES AND CO., Limited, sole makers of the well-known "McInnes-Dobbie" indicators, have removed their office from 113, Fenchurch-street, to 16, London-street, Fenchurch-street.

MESSRS. E. C. AND J. KEAY, Limited, inform us that they have appointed Mr. Louis Marshall, consulting engineer, St. James' Chambers, 38, Church-street, Sheffield, to be their sole agent for the counties of York and Lincoln.

THE HASLAM FOUNDRY AND ENGINEERING COMPANY, Limited, incorporated with Pontifex and Wood, London, is removing to new offices on the 25th inst., and its address will then be 175 to 177, Salisbury House, London Wall, London, E.C.

MESSRS. EDWIN DANKS AND CO. (OLDBURY), Limited, boiler-makers, have opened a London office at 52, Lime-street, in charge of Mr. James Gordon, A.M.I. Mech. E., to whom all inquiries should be sent from London and district, Surrey, Kent, and Essex.

MESSRS. REAVELL AND CO., of Ipswich, report orders for their new motor-driven variable speed compressors from Messrs. Ruston, Proctor and Co., Lincoln; the English Admiralty, Sheerness Dockyard; Natal Government Railways; and the Thames Ironworks, Limited.

MESSRS. EVERSHED AND VIGNOLES, Limited, give notice that they are completing the removal of their business to the new factory which they have built at Acton Green, Chiswick; and that on and after Monday, June 15th, 1903, all letters and goods should be addressed to their new address, Acton-lane, Chiswick London, W.

MESSRS. BARFORD AND PERKINS, of Peterborough, have been sending out a good many of their specialities to South Africa of late. Steam ploughing machinery is also made by this firm, and there are many inquiries just now from the Colony for it. An ordinary portable or traction steam engine only is required, and excellent results can be obtained.

MR. W. R. BATES, who has been the chief engineer to the Ebbw Vale Steel, Iron, and Coal Company, Limited, for the last few years, has been appointed to succeed Mr. H. Brown as manager of Messrs. James Oakes and Co., Alfreton Ironworks, Derbyshire. Mr. Bates served his apprenticeship with the Butterley Company, and was subsequently engineer to Messrs. Oakes, and before coming to Ebbw Vale was engineer to the Brymbo Steel Company, Wrexham, for several years.

MIRRLEES, WATSON AND CO., of Glasgow, have received the order for the condensing plant for the Yoker Station of the Clyde Valley Electrical Power Company. The plant consists of three surface condensers, vertical, each having 6250 square feet surface; three sets horizontal dry air pumps, steam-driven; three sets vertical spindle condensed water pumps, motor-driven; three sets centrifugal circulating pumps, motor-driven. Each plant deals with a maximum of 66,000 lb. of steam an hour.

OWING to the death of the senior partner—Mr. W. J. Lister—of the Lister Electric Manufacturing Company, of Dursley, Gloucestershire, the following changes have taken place in this concern. Mr. G. del Rivo, who entered the business last year, has retired, and Messrs. R. A. Lister and Co., Limited, have purchased the business, in which Mr. Fraser Lister will continue to be engaged. The Lister Electric Manufacturing Company will be represented in London as heretofore by Messrs. Pinchin and Walton, 52, Cannon-street, E.C., whilst the branch offices and agencies in Glasgow, Newcastle, Liverpool, and Belfast will also be continued.

EASTON AND CO., Limited, within the last fortnight have received orders for superheater plants from the Witham Urban District Council, for their Waterworks Pumping Station; the Electricity Works, Blackpool, Lancs.; Messrs. James Oakes and Co., of Alfreton; the Associated Portland Cement Manufacturers, of Grays, Essex; the Sneyd Colliery and Brick Company, Limited, of Burslem; and Messrs. White, Cottell and Co., of Camberwell. The plants in question amount in the aggregate to upwards of 7000 horse-power. The superheater plants delivered or on order since Messrs. Easton and Co. first took up the business about two years ago aggregate very nearly 100,000 horse-power.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

2nd June, 1903.

12,491. Boat-propelling Mechanism, F. A. Creed, Kingston-on-Thames.
12,492. Ribbon Mechanism for Typewriting Machines, A. M. Clark.—(*The Underwood Typewriter Company, United States.*)
12,493. Paper Bags, J. Westaway, London.
12,494. Casting Type, F. H. Brown, J. E. Hanrahan, and G. A. Boyden, London.
12,495. Throttle Valves, W. H. and R. W. Allen, London.
12,496. Looms, S. Walker, London.
12,497. Preparing Skin, E. J. Donner and T. C. Mills, London.
12,498. Anti-vibration Swaging Anvil, H. W. Sutcliffe, London.
12,499. Pipe Wrenches, W. P. Thompson.—(*F. D Bullard, United States.*)
12,500. Casks, A. Jaffa, Liverpool.
12,501. Oars, H. B. Murdock, Liverpool.
12,502. Motors for Vehicles, C. T. Osborne, Liverpool.
12,503. Tea-pot Strainers, A. F. Barnett, London.
12,504. Casting Glass, J. R. Speer and H. A. Otto, London.
12,505. Saucers, E. Lambardt, London.
12,506. Gas Producers, La Société Française de Constructions Mécaniques (Anciens Etablissements Cail), London.
12,507. Conveyor Apparatus, A. T. Hagen and D McC. Cooper, London.
12,508. Window Shade Fixtures, G. R. Jennings, London.
12,509. Pneumatic Action for Musical Instruments, M. S. Wright, London.
12,510. Hot-air Furnaces, J. M. Beech, London.
12,511. Seaming Machines, J. W. Mackenzie.—(*E. W. Bliss Company, United States.*)
12,512. Moulding Plastic Forms, R. Haddan.—(*C. Rolland and G. A. Ström, France.*)
12,513. Dyeing Photographic Plates, G. Selle, London.
12,514. Photographic Cameras, G Selle, London.
12,515. Photographic Colour Screens, G. Selle, London.
12,516. Electro-magnetic Machine, C. F. Pichard, London.
12,517. Locks, C. B S. Möller, London.
12,518. Evaporating Apparatus, R. Haddan.—(*E. R. Edson, United States.*)
12,519. Building Walls, O. U. Miracle and W. L Dow, London.
12,520. Saucepan and Strainer, W. Gardner, jun., London.
12,521. Medical Ozoniser, M Otto, London.
12,522. Ferro-electric Filter, M. Otto, London.
12,523. Mosaic, L. Schlentheim, London.
12,524. Machine Chucks, O. Imray.—(*A. V. Roveley, Germany.*)
12,525. Commode Drawers, O. Imray.—(*C. Sponholz, Germany.*)
12,526. Electric Cables, W. Dieselhorst and A. W. Martin, London.
12,527. Brakes for Hoisting Apparatus, R. Dubois, London.
12,528. Method of Treating Peat, W. A. Milne, London.
12,529. Moisture Regulating Apparatus, W. A. Milne, London.
12,530. Garbage Consumers, A. R Denison and J. Curry, London.

3rd June, 1903.

12,531. Targets, P. O'Carroll and J. C. Bunce, Southsea.
12,532. Stands for Motor Bicycles, W. B. Robertson, Glasgow.
12,533. Bats, W. Wallace, Glasgow.
12,534. Golf Balls, J. H. M. Gillies, Glasgow.
12,535. Raising Fire-escapes, E. Lansing and E. F. Burch, Manchester.
12,536. Dry Stands, A. Travis Stalybridge.
12,537. Bolts, S. W. Gillett.—(*A. D Molison and J. W. White, Transvaal.*)
12,538. Ground Rope Rollers, W. Swinburn, Great Grimsby.
12,539. Curtain Hook, W. J. Houlgate, Fleetwood, Lancs.
12,540. Valves, T. Sim, Govan.
12,541. Starting Combustion Engines, D. Mottershead, Manchester.
12,542. Bottle, W. H. Peach, Portsmouth.
12,543. Wickless Burner, J. F. Snell and E. C. Whelan, Chorlton-cum-Hardy.
12,544. Automatic Control of Engines, T. Linford, Thornton, near Leicester.
12,545. Free-wheel Motor, J. and T. Larkin, West Kirby, Cheshire.
12,546. Ratchet-and-pawl Mechanism, J. W. Smallman, Margate.
12,547. Laundry Irons, R. Marston, Liverpool.
12,548. Electric Ignition on Motor Engines, J. McD. Boyd and J. Aimers, Galashiels.
12,549. Railway, O. Starke, London.
12,550. Window Blind Rollers, T. S. McC. Stewart, London.
12,551. Eye-glass Adjuster, P. Donaldson, London.
12,552. Shoes, E. E. A. Cove, London.
12,553. Fixing Separate Pieces to a Base. W. Richard and The Diamond Sign Company, Limited, London.
12,554. Lavatory Flushing Apparatus, C. F. V. Flint, London.
12,555. Sterilisation of Milk, N. Bendixen, London.
12,556. Boiler Furnaces, Clayton and Shuttleworth, Limited, and W. Whinney, London.
12,557. Typewriting Machines, N. L. Anderson, London.
12,558. Safety Guards for Machine Cylinders, H. Symonds, London.
12,559. Separation of Organic Material, J. C. King, London.
12,560. Dry Hopping Machines, J. W. Flower, London.
12,561. Ventilating Boots and Shoes, H. Manning, London.
12,562. Time Recorders, C. A. Mercier, London.
12,563. Coin-actuated Electrical Apparatus, J. Rose and Rose, Coop, and Rissone, Limited, London.
12,564. Drinking Vessel Tablets, H. E. Russell and P. Burke, London.
12,565. Gas Engines, E. E. Arnold, London.
12,566. Hand Saws, F. E. R. Okrassa, London.
12,567. Heating or Cooking Stoves, P. S. Spiller, London.
12,568. Road Sweeping Brooms, C. Walkden, London.
12,569. Malt-turning Machines, D. D. Weschler, London.
12,570 Shafting for Transmission of Power, J. G. Nash, London.
12,571. Detachable Shade for Bonnets, K Lancaster, London.
12,572 Range-finding Apparatus, L. W. Sterne, London.
12,573. Stencils for Reproducing Patterns, H. E. Ablett, London.
12,574. Railway Signalling Apparatus, F. L. Dodgson, London.
12,575. Picker-stick Lug-straps for Looms, R. G. Campbell, Liverpool.
12,576. Cleaning Printing Presses, J. Honeyman and A. Smith, Liverpool.
12,577. Safety Lock for Windows, M. R. Green, Liverpool.
12,578. Dry-battery for Nervous People, G. W Gessmann, London.
12,579. Conveyor for Projectiles, C. P. E Schneider, London.
12,580. Extraction of Liquids by Evaporation, F. Calmant, London.
12,581. Knobs for Stick of Umbrellas, S. Ruhmann, London.
12,582. Coating Articles of Earthenware, M. Polack, London.
12,583. Working the Levers in Signal Boxes, L. Piot, London.
12,584. Making Composition from Calcined Gypsum, L. Mack, London.
12,585. Rim Brakes for Cycles, P. J. Ogle, London.
12,586. Mowing and Reaping Machines, S. B. Pamford, London.
12,587. Incandescent Gas Lamps, A. A. Bordier, London.

4th June, 1903.

12,588. Expansion Sockets for Pipes, J. Stewart, London.
12,589. Lacing of Articles of Apparel, J. Hennessey, J. Rowan, J. H. and J. F. Mallaney, Kingston-on-Thames.
12,590. Multiple Sparking Device for Motors, A. B. Chapman, Ipswich.
12,591. Cigarettes with Matches, R. S. Bradbury, Congleton, Cheshire.
12,592. Gearing, T. S. James, G. W. de Tunzelmann, and H. F. P. Hawkins, London.
12,593. Illuminant Appliances for Gas Burners, J. T. McQuinn, Altrincham.
12,594. Gas Burners for Incandescent Mantles, J. T. McQuinn, Altrincham.
12,595. Cigar Box Lid and Ticket-holder, J. C. Thurley, Burnley.
12,596. Gauge Taps, A. W. Death, Leicester.
12,597. Compositors' Setting Rule and Pica Gauge Combined, R. H. Lange, Armley, Leeds.
12,598. Railway Signalling, L. B. Stevens, London.
12,599. Motor Car Fittings, F. W. Lanchester, Birmingham.
12,600. Automatic Oil Distributors, H. Frenay, Birmingham.
12,601. Apparatus for Monetary Change, K. Rotherham, J. Jackson, and W. Johnson, Coventry.
12,602. Speed Gear for Driving Motor Cars, W. V. Foulis, Glasgow.
12,603. Metallic Closures for Bottles, H. C. Heide —(*A. L. Weisthanner, United States.*)
12,604. Apparatus for Boiling Ham, J. Kilberth, Hamburg.
12,605. Money Box to Place Upon a Wall, W. Standers and J. P. Humphris, London.
12,606. Pneumatic Stem, G. J. Whitfield, Birmingham.
12,607. Railway Milk Churns, J. Struthers and G. A. Dowse, London.
12,608. Carriage Door Windows, F. R. Bennett, London.
12,609. Gaining Wine and Coognac out of Plums, A. Kier, London.
12,610. Propelling Device, J. Lanz, London.
12,611. Fastening Device for Transportable Hydraulic Presses, H. Huber, London.
12,612. Shooting Galleries, C. C. Reinhardt, London.
12,613. Fountain Pens, H. B. Levy, London.
12,614. Railway Rail Joints, J. C. Wallace, London.
12,615. Railway Couplings, E. S. Chapman, London.
12,616. Tobacco Pipes, W. Warren, London.
12,617. Dummy Typewriter Keyboard, C. Freakes, London.
12,618. Collecting Electricity from Conduit, F. Hewer, London.
12,619. Supplying Purified Water from Exhaust Steam, F. Meyer and J. Batcheler, London.
12,620 Separating Grease, F. Meyer and J. Batcheler, London.
12,621. Machine for Nibbling Cocoa Beans, J. Barron and S. K. Green, London.
12,622. Running Gears, G. H. Condict, London.
12,623. Chain Wheels for Motor Cars, S. B. Joyce, London.
12,624. Bed Coverings, E. W. Brown, London.
12,625. Steering Mechanism for Motor Vehicles, C C. Wright, Gunnersbury.
12,626. Leggings, F. J. Jones, London.
12,627. Method of Casting Metal, A. Sauveur, London.
12,628. Manufacture of Bottle Casings, C. B. E. Henka and G. A H Schulte, London.
12,629. Electric Alarms, C. E. Grouselle and V. E. Manouvrier, London.
12,630. Factory Clocks, P. Paaskesen, A. Juhl, and P. Petersen, London.
12,631. Apparatus for Delivering Coins, M. Sandler, London.
12,632. Cleansing Textile Fabrics, G. J. Byrne, London.
12,633. Oars, Sculls, &c., G. J. Ayling, London.
12,634. Repairing Appliance for Pneumatic Tires, W. F. Parker, London.
12,635. Brushes, A. W. Corrie, London.
12,636. Concrete Structures, W. N. Wright, London.
12,637. Delivery Device for Cattle, H. Bargeboer, London.
12,638. Attaching Collars to Shirts, P. Weise, London.
12,639. Explosion Engines, T. H., E., and L. Gardner, London.
12,640. Bag Holders, G. E Brown, London.
12,641. Snap Hooks, T Forstner, London.
12,642. Screens for Windows and Doors, F. C. Wright, London.
12,643. Bindings for Hats, C. E. Clark, London.
12,644. Separation of Zinc Blende from Ores, A. F. Spooner.—(*Magnetic Ore Separating Company Proprietary, Limited, Victoria, Australia.*)
12,645. Protective Composition, O. A. Stempel, London.
12,646. Decolourising Tobacco Leaves, A Nauwelaers, London.
12,647. Tires for Railway Vehicles, F. Stephan, London.
12,648. Covered Elastic Bands, R. B. Price, London.
12,649. Horseshoes, R. B. Price, London.
12,650. Condensing Apparatus for Vapour Motors, T. Reuter, London.
12,651. Making of Earthenware Pipes, R. Stanley, London.
12,652. Collapsible Baths, A. Grosbois, London.
12,653. Manufacture of Peat Blocks, R. A. Kellond and J. C. Morrison, London.
12,654. Elastic Tires for Vehicle Wheels, F. Tillmany, San Francisco, United States.
12,655. Sashes, A. Jenkins, Chester.

5th June 1903.

12,656. Boots and Shoes, A. Don Puchner and T. G. Heine, Kingston-on-Thames.
12,657. Rotary Motors, J. M. Crowley, C. F. Smith, R. Storey, and T. B. Milton, Kingston-on-Thames.
12,658. Bearings for Vertical Shafts, C. H. Frött, Barmen, Germany.
12,659. Tobacco Smoking Pipes, W. Baines, Ashton-on-Ribble, Preston.
12,660 Ground Brakes for Rail, S. I. Cross, Dovercourt, Essex.
12,661. Tobacco Pipes, D. W. Allman, Manchester.
12,662. Apparatus for Sharpening Chaff Cutter Knives, J. H. Turner and G. A. Gray, Warminster.
12,663. Stoppering of Bottles, F. A. Bird, Birmingham.
12,664. Gas and Oil Engines, W. Rowbotham, Birmingham.
12,665. Improved Heat Protector, J. W. Blakey, Bradford.
12,666. Fishing Gear, J. A. and A. S. Duthie, Aberdeen.
12,667. Combined Pencil Holder and Knife, A. Logan, Liverpool.
12,668. Water Hose and Steam Unions, A. Blatchford, Guernsey.
12,669. Anti-vibration Cycle Saddle, C. Osborne, Kidderminster.
12,670. Shields for Preventing Punctures, A. Everett, Folkingham, Lincs.
12,671. Shuttles for Looms, J. Brookes, Belfast.
12,672 Shuttle for Weaving, W. Ellis and J. Buller, Colne, Lancs.
12,673. Detecting Tampering with Cases, F. Wallace, London.
12 674 Making Blotting Paper, J. Hawke, New Barnet.
12,675. Making Blotting Paper, J. Hawke, New Barnet.
12,676. Actuating Door Openers, G. T. Richardson, London.
12,677. Photographic Printing Apparatus, H. H. McIntire, London.
12,678. Pruning Implements, H. A. Hill, London.
12,679. Garment Hangers, A. F. Parnum, London.
12,680. Pianos, P. Duffy, London.
12,681. Manufacture of Soluble Salts. J. Y. Johnson.—(*Badische Anilin and Soda Fabrik, Germany.*)
12,682. Moulds for Making Bricks, J. F. Gray, London.
12,683. Electric Conduit Traction, W. Cope, Birmingham.
12,684. Combined Stamp Container, W. J. Hornby, London.
12,685. Acetylene Lamps, A. E. Purrott and E. W. Willard, Birmingham.
12 686. Picture Frame Cramp, G. Gregory, London.
12,687. Trucks for Railway Vehicles, H. R Keithley, London.
12,688. Universal Feed Tables, H. P. Elwell, London.
12,689. Sound-producing Instrument, A. Junghans, London.
12,690. Outdoor Seats, W. E. Smith, London.
12,691. Gas Burners, E. G. Leonard and P. C. Hughes, London.
12,692. Washing Photographic Plates, H. Bennett and P. J. W. Barker, London.
12,693. Pneumatic Tires, W. H. Dawson and J. Stott, London.
12,694. Manufacture of Golf Balls, H. G. Rose, Birmingham.
12,695. Preserving Perishable Produce, A. E. Bertie-Smith and F. A. Schouten, London.
12,696 Treating Tar, W. Oppenheimer and T. O. Kent, London.
12,697. Bottle Stoppers, E. H. Aydon and C. Parsons, Manchester.
12,698. Composite Material for Decorating, A. Loisel, London.
12,699. Distribution Valve Gear, V. E. Brout, London.
12,700. Vent Peg for Barrels, T. H. H. Kibbler, London.
12,701. Concrete Structures, W. N. Wight, London.
12,702. Apparatus for Propelling Ships, C. A. Matthey, London.
12,703. Adjusting Ignition in Explosion Engines, F. Labanhie, London.
12,704. Covering for Soap, G. Bartl and Hannoversche Gummi-Kamm-Compagnie Actien-Gesellschaft, London.
12,705. Motor Car Road Indicator, B. F. Sobotka, London.
12,706. Flexible Metallic Tubing, W. H. K. Bowley, London.
12,707. Coin-Freed Stamp-vending Machine, L. Spiegel, London.
12 708. Loading Hay, H. H. Harman and W. A. Parks London.
12,709. Device for Adjusting Piston Rings, P. Bode, London.
12 710. Motor Cars, A. L. Bricknell, London.
12,711. Concertina, E. A da C. Seixas, London.
12,712. Quick-drying Varnishes, T. Abelmann, London.
12,713. Making White Lead. H. H. Lake.—(*Syndicat pour l'Exploitation des Inventions du Professor Oettli, Switzerland.*)
12,714. Rail Joints, H. B. Nichols, London.
12,715. Obtaining Power by Atmospheric Compression, G. James and E. J. Richardson, London.
12,716. Electric Gas-igniting Device, H. Bergner, London.
12 717. Golf Balls, K. V. Painter, London.
12,718. Valve-controlling Gear, O. Grässler, London.
12,719. Making Oxide of Zinc, H. H. Lake.—(*Syndicat pour l'Exploitation des Inventions du Professor Oettli, Switzerland.*)
12,720. Centrifugal Apparatus, E. C. Küchenmeister, London.
12 721. Grinding and Milling Machine, J. M. Olsson, London.
12,722. Measuring Apparatus for Electricity, G. Many, London.

6th June, 1903.

12,723. Raising Coal from Mines, W. G. Cowlishaw, Stoke-on-Trent.
12 724. Making Pipe Joints, H. P. Embrey, Stoke-on-Trent.
12,725. Mixing Hydrocarbons with Air, G. C. Taylor, Helsby, near Warrington.
12,726. Telephone Mouthpiece, J. Ashton, Rathmines, Co. Dublin.
12,727. Making Metallic Vanadium, P. Auchinachie, Ffrith, near Wrexham.
12,728. Punching Apparatus, P. B. Hughes and V. Canova. Birmingham.
12,729. Explosion Motors, C. G. Borthwick, Manchester.
12,730. Shadowless Back Lantern, G. Bocock and J. Wilkinson, Birmingham.
12,731. Drawing-boards and T Squares, A. Tambling, Bristol.
12 732. Manufacture of Steel, G. Hatton, Brierley Hill, Staffs.
12,733. Portable Tents, W. Cutler. Birmingham.
12,734. Forks for Hay, J. Gretton and R. T. Broughton, Derby.
12,735. Laundry Ironing Machines, W. A. Lees, Leeds.
12,736. Conveying and Screening Machinery, G. Smith, Sheffield.
12,737. Seats for Tramcars, D. Collins, Northam, Southampton.
12,738. Box Mechanism for Looms, E. Hollingworth, Dobcross, Yorks.
12,739. Articles of Dress, W. H. J. Masding, Bristol.
12,740. Self-acting Cork Feeders, A. M. Plunkett, Liverpool.
12,741. Steering Engines, K. M. Alley, Glasgow.
12,742. Gramophones, C. H. Harding, Huddersfield.
12,743. Road Wheels for Motor Cars, F. A. and C. Hall, Birmingham.
12,744. Means for Protecting Seeds, A. S. Corbett, Birmingham.
12,745. Controlling Switch for Electrically-driven Hoists, A. M. Morrison and A. McN. Mackechlan, Glasgow.
12,746. Internal Combustion Engines, F. J. Gillibrand, Liverpool.
12,747. Trouser Stretchers, A. S. Govan, Glasgow.
12,748. Securing Ridge Tiles, G. T. McCaw and H. R. Vaughan, Glasgow.
12,749. Appliance for Holding Windows, E. R. Wood, Liverpool.
12,750. Mechanism for Sewing Machines, W. N. Parkes, Glasgow.
12,751. Rock-drilling Machine, J. G and J. Heimrich, Glasgow.
12,752. Telephone Switchboard, W. Aitken, Egremont, Cheshire.
12,753. Game, C. H. and A. Johnson, Leeds.
12,754. Heels for Boots and Shoes, J. Ince, Blackburn.
12,755. Buoyant Rubber Heels, E E. Daniels, Bath.
12,756. Pneumatic Tires, M. Reynolds, London.
12,757. Steam Engines, G. McClure, London.
12 758. Shirts and Underclothing, W. G. Farrow, London.
12,759. Washing Tubs, Troughs, &c., W. Mark, London.
12 760. Roller Fluting Machines, J. H. Eurton, London.
12,761. Device for Chopping Suet, S. Sedgwick, London.
12,762. Controlling the Exit of Animals, D. Foulis, London.
12,763. Automatic Couplings, A. Beaugeois and W. J. Flynn, London.
12,764. Spools, A. Salzmand, Liverpool.
12,765. Hoists, W. P. Thompson.—(*M. C. White and O. C. Duryea, United States.*)
12 766. Apparatus for Propulsion of Vessels, C. M. Coen, London.
12,767. Emergency Brakes, A. L. von Steuben, London.
12,768. Metallic Railway Ties, C. S. Seitz London.
12,769. Safety Appliance for Railways, C. Bergmann, London.
12,770. Regulating Device for Wheels in Metres, O. Piper, London.
12,771. Thumb Latches, J. W. Rhodes, London.
12,772. Apparatus for Taking Photographs, A. Maul, London.
12,773. Manufacture of Colloidal Bismuth-oxide, G. W. Johnson.—(*Kalle and Co., Germany.*)
12,774. Pumps, H. H Lake.—(*Southwark Foundry and Machine Company, United States.*)
12,775. Combs, H. H. Lake.—(*—. Scranton, United States.*)
12,776. Coal Mining, D. Janko, J. Kiss, and K. Stirling, London.
12,777. Disinfecting Infected Clothing, H. D. Bishop and A. L. Davis, London.
12,778. Separating Metal from Crushed Ores, W. N. Turner, London.
12,779. Manufacture of Alkali Metal, Castner Kellner Alkali Company, Limited, and A. G. Haddock, London.
12,780. Hoisting Apparatus, C. W. Hunt, London.
12 781. Hoisting Apparatus, C. W. Hunt, London.
12,782. Hoisting Apparatus, C. W. Hunt, London.
12,783. Preventing Dust Accumulating, R. Blakoe, London.
12,784. Blowing Engines, H. H. Lake.—(*Southwark Foundry and Machine Company, United States.*)
12,785. Slide Valves, H. H. Lake.—(*Southwark Foundry and Machine Company, United States.*)
12,786. Lifts Used in Public Buildings, R. A. Briggs, London.
12,787. Manufacture of Boots and Shoes, K. Daut, London.
12,788. India-rubber Tires for Vehicle Wheels, R. E. Soulas, H. Deffes, and E. H. Paindavoine, London.
12 789. Travelling Grate for Coal Furnaces, A. Müller, London.
12,790. Internal Combustion Engines, E. A. Rundlöf, London.
12,791. Clutch for Motor Cycles, P. M. Gayon, London.
12 792. Tins, J. H. C. Colton, London.
12,793. Support for Ships' Furniture, B. Ellinger, London.
12,794. Motor Cars, F. Keith-Jones, London.
12,795. Mudguards for Cycles, &c, A. Hauber, London.
12,796. Water-heaters, R. Marlcke, London.
12,797. Means for Cleaning the Teeth, A. G. Wohlfarth, London.
12,798. Therapeutic Products, E. Langheld, London.
12,799. Containers for Molten Glass, H. H. Lake.—(*The Toledo Glass Company, United States.*)
12 800. Motors, J. D Roots, London.
12,801. Meter with Rotary Field for Measuring, Compagnie Anonyme Continentale pour la Fabrication des Compteurs à Gaz et autres Appareils, London.
12 802. Electric Motors for Electrically-propelled Vehicles, Siemens Brothers and Co., Limited, A. Siemens, and A. M. Duke, London.
12,803. Quadrant and Level, W. Potter, New York.
12,804. Bicycle Brake Lock, A. C. W. Mallett, London.

8th June, 1903.

12,805. Bottle Neck, C. S. Froom, Chorley, Lancs.
12,806. Antilithic Soap, O. A. Elias, London.
12,807. Lubricators, W. T. Rowden, Helensburgh, N B.
12,808. Lever for Spinning Mules, G. Crowther, Halifax.
12,809. Vehicle Couplings, C. M. A. and F. V. Culverhouse, London.
12,810. Rolling Cloth, J. McKean, Castle Blayney, Co. Monaghan.
12,811. Apparatus for Starting Races, A. P. Hawksley, Altrincham
12,812. Lorry Wheels, E. J. B. and K. Lowdon, and W. A. Keay, Dundee.
12,813. Engraving Metallic Surfaces, W. A. and C. A. Ker, Glasgow.
12,814 Lorry Boilers, E J. B. and K. Lowdon, and W. A. Keay, Dundee.
12,815. Coal-holing Machines, A. E. Millward, Accrington.
12,816. Manufacturing Table Cutlery, G. T. Drabble, Sheffield.
12,817. Driving Chains, H. Renold and H. Renold, Limited, Manchester.
12,818. Extension Arm for Phonographs, G. Noble, Glasgow.
12,819. Charging Gas Retorts, W. P. and G. B. A. Gibbons, Birmingham.
12,820. Charging Gas Retorts, W. P. and G. B. A. Gibbons, Birmingham.
12,821. Fishing Reel, G. N. Wilson, Aberdeen.
12,822. Controlling Valves for Engines, R. Richardson, Glasgow.
12,823. Furnaces, F. H. Wollhuver and M. Sjögren, Berlin.
12,824. Frames for Training Flowers, W. A. Russell, Glasgow.
12,825 Fire-escapes, R. J. and P. Wallace, Glasgow.
12,826. Ships' Anchors, R. W. Boxill. Glasgow.
12,827. Fishing-rod Tackle, W. Smallwood. London.
12,828. Folding and Portable Bedstead, S. Ludzer, London.
12,829. Telephone Exchange Systems, H. Oppenheimer.—(*Actiengesellschaft Mix and Genest, Germany.*)
12,830. Hat Clip Holder, P. Saager, London.
12,831. Acetylene Gas Lamps, J. Bartlett, London.
12,832. Superheating Steam, S. McEwen.—(*D. C. Smith, Western Australia.*)
12,833 Pipe and Nut Wrenches, G. E. Carnes, St. Louis, Missouri, United States.
12,834 Bottle-closing Devices, C. Holt, London.
12,835. Measuring Apparatus for Sacks, F. Kilian, London.
12,836. Roll or Wrapper for Tape, F. H. Amsden, London.
12,837. Electric Motors. E. A. Carolan.—(*The General Electric Company, United States.*)
12,838. Electric Heaters, E. A. Carolan.—(*The General Electric Company, United States.*)
12,839. Controllers for Electric Motors, E. A. Carolan.—(*The General Electric Company, United States.*)
12,840. Self-lubricating Drill-cutter Bar for

CUTTING METALS, J. Murphy and J. A. Hamon, London.
12,841. HEELS for BOOTS, P. H. Head and L. M. Bennett, London.
12,842. CONSTRUCTION of LOOP RAILWAYS, W. E. Crist, London.
12,843. OZONISER, J. F. Hoyne, London.
12,844. SHAPING TONGS for BOTTLE NECKS, O. Schäfer, London.
12,845. REMOVING DIRT from GROOVES of TRAM RAILS, O. Winkelströter, London.
12,846. ATTACHMENT for DOOR KNOBS, H. Birkbeck.—(*The New York Lock Company, United States.*)
12,847. MANUFACTURING PNEUMATIC TIRES, L. Johnstone, London.
12,848. INCANDESCENT GAS MANTLES, H. Birkbeck.—(*F. J. Cullum, Belgium.*)
12,849. WIND MUSICAL INSTRUMENTS, Besson and Co., Limited, and T. C. Edwards, London.
12,850. CASTING STEREOTYPE PLATES, C. E. Hopkins and F. Wesel, London.
12,851. VALVES for STEAM ENGINES, H. Birkbeck.—(*The Brooks Improved Steam Valve Company, United States.*)
12,852. HAT HOLDER, E. Drew, London.
12,853. REMOVABLE WOODEN CHILLINGS, P. B. Guilhau London.
12,854. SKEIN-DYEING MACHINE, J. W. Finegan, Kingston-on-Thames.
12,855. DECK for MARINE VESSELS, J. W. Powell, Kingston-on-Thames.
12,856. PROCESS of MAKING PICKLES, W. A. Loder, Kingston-on-Thames.
12,857. BLOWING ENGINES, H. H. Lake.—(*Southwark Foundry and Machine Company, United States.*)
12,858. PLAYING BALLS, C. B. Elliott, London.
12,859. ADJUSTABLE TRUMPET HOOD, F. T. Shepherd, London.
12,860. BLOWING ENGINES, H. H. Lake.—(*Southwark Foundry and Machine Company, United States.*)
12,861. DRYING KILNS for CERAMIC WARE, F. Dinz, London.
12,862. PUMPS, H. H. Lake.—(*Southwark Foundry and Machine Company, United States.*)
12,863. DEVICE for FOLDING ENVELOPES, B. Eckner, London.
12,864. SWIVELLING COUPLINGS, R. Thompson.—(*C. Brown, Switzerland.*)
12,865. ELECTRIC BURGLAR ALARMS, C. O. Miller, London.
12,866. TRANSFERRING CARGO from SHIPS, M. J. Paul, London.
12,867. PRESERVING EGGS, G. C. Marks.—(*A. Pfaff, Victoria.*)
12,868. VAPOUR ENGINES, G. C. Marks.—(*A. A. Low, United States.*)
12,869. CLEANING TUBES, &c., P. R. Sewell.—(*F. Nowotny, Germany.*)
12,870. CURTAIN HOLDER, W. F. Donovan and G. Baumann, London.
12,871. BOTTLE STOPPER, W. F. Donovan and G. Baumann, London.
12,872. LOCK for WASHING MACHINES in STEAM, W. F. Donovan and G. Baumann, London.
12,873. DOOR KNOCKERS, W. J. Peckett, London.
12,874. MACHINES for TURNING HAY, W. E. Martin, London.
12,875. LOCKING DEVICE for PROJECTILE FUSES, H. P. Merriam, London.
12,876. PUMPS, H. H. Lake.—(*Southwark Foundry and Machine Company, United States.*)
12,877. XEROGRAPHS, G. Bruce, London.
12,878. SUPPORTING DRILLING MACHINES, J. Brown, London.
12,879. SULPHUR DYES, G. B. Ellis.—(*Chemische Werke vormals Sandoz, Switzerland.*)
12,880. APPARATUS for PUMPING MOLTEN METALS, F. Wicks, London.
12,881. APPARATUS for CASTING PROJECTILES, F. Wicks, London.
12,882. FLESHING and SHAVING SKINS, E. Schroeder, London.
12,883. EYELETTING MACHINES, A. J. Boult.—(*United Shoe Machinery Company, United States.*)
12,884. SUPPORT for TOILET PAPER ROLLS, A. Shoemann, London.
12,885. UMBRELLA TIP RETAINERS, J. Coventry, London.
12,886. FLY-WHEELS for HIGH-SPEED ENGINES, F. Reichenbach, London.
12,887. GIRDERS, F. Pohlmann, London.
12,888. APPARATUS for CLEANING CARPETS, R. Backhaus, London.
12,889. MECHANISM for DRIVING VEHICLES, F. Campens, London.
12,890. COMBING FLAX, R. Haddan.—(*La Société Anonyme de la Lys, Belgium.*)
12,891. PUMPS, H. H. Lake.—(*Southwark Foundry and Machine Company, United States.*)
12,892. CONSTRUCTION of COLLAR FRAME, C. Morfey, London.
12,893. ROTARY ENGINE, C. H. Jolliffe and A. Coulthard, London.
12,894. ATMOSPHERIC BURNERS, A. Schapiro and H. Hurwitz, London.
12,895. SOFT METAL HEADED WIRE NAILS, J. B. Davies, London.
12,896. LUBRICATORS, J. H. Johnston, London.
12,897. BATTERY SOLUTION, C. E. Warren and J. Crowley, London.
12,898. MOULD DRIER and VULCANISER, R. H. Smith, London.
12,899. MOULDING ARTIFICIAL STONES, A. Gaspary, London.
12,900. LOOMS for WEAVING MACHINES, W. H. Baker, Liverpool.

9th June, 1903.

12,901. STEAM CONDENSERS, J. E. Weyman, Edinburgh.
12,902. FIRE-ESCAPE, J. J. Gilbert, Northampton.
12,903. CHIPPING or CAULKING TOOL, H. B. Stocks, Birmingham.
12,904. CRICKET BAILS, J. C. Bunce, Southsea.
12,905. ROAD-WATERING APPARATUS, R. Diggle and W. J. Newton, Accrington.
12,906. TROLLEY WHEELS for ELECTRIC CARS, H. Brecknell, E. M. Munro, and H. J. Rogers, Bristol.
12,907. TRIGGER GUARDS for GUNS, T. B. Kinder, Leamington.
12,908. FIRE ALARM, J. Jennett, Belfast.
12,909. SAFETY GUARD for HATCHETS, R. Morgan, Pontypridd.
12,910. CASK-TAPPING DEVICES, J. Wass and F. Tyler, Leicester.
12,911. FOOD CHOPPERS, P. H. Bertrand, Birmingham.
12,912. ENVELOPES, A. Hall, Liverpool.
12,913. CONNECTING ROPE ENDS, W. H. Nield and W. Melland, Manchester.
12,914. FIRE EXTINGUISHERS, R. J. Wilkinson, Manchester.
12,915. ARC LAMPS, J. W. Bowley, Manchester.
12,916. SPINDLE FOOTSTEPS for SPINNING MULES, J. Travis, Manchester.
12,917. PREVENTING SIDE-SLIP with VEHICLES, G. Gillmore, Manchester.
12,918. CIGARETTE BOXES, G. Graham, Sheffield.
12,919. FINISHING TEXTILE FABRICS, C. Wood, Manchester.
12,920. STORING WHEAT, G. A. Jarvis, London.
12,921. AFFIXING SEALS to BOTTLES, C. J. Sellar and J. M. Munro, Glasgow.
12,922. CANOPY for MAIL CARTS, A. E. Sumner, Moseley, Birmingham.
12,923. CYCLE SADDLE PAD, J. Hertzog and T. T. Pope, Wolverhampton.
12,924. BOXES, T. S. Kendrick and D. W. Snaith, Sparkbrook, Birmingham.
12,925. VEHICLE COUPLINGS, R. Parkin, Newburn, Northumberland.
12,926. CLIPPING MACHINES, W. S. Foster, Glasgow.
12,927. PULP WASHING and BEATING ENGINES, J. Hall, Glasgow.
12,928. FIRING FURNACES, W. Fairweather.—(*A. A. Ramsdell, United States.*)
12,929. TOY, W. M. Moseley, Glasgow.
12,930. ANGLE SHAFT COUPLINGS, S. W. Robinson, Glasgow.
12,931. WRAPPING MACHINE, W. Fairweather.—(*W. B. Page and A. E. Hopkins, United States.*)
12,932. ROTARY ENGINES, G. C. Marks.—(*The International Sheuhan Rotary Engine Company, United States.*)
12,933. PNEUMATIC HAMMERS, G. C. Marks.—(*The Chicago Pneumatic Tool Company, United States.*)
12,934. TRANSLATING POWER, W. O. Worth and W. R. Donaldson, London.
12,935. PACKING TUBES, G. C. Marks.—(*E. A. McMillen and J. A. Leggett, United States.*)
12,936. CORSETS, F. M. Kaye, London.
12,937. COLLARS, W. Wrathall, London.
12,938. SPEED INDICATOR for VEHICLES, F. J. Caparn, London.
12,939. APPARATUS for SEPARATING MASSES, J. T. Burr, London.
12,940. SPINNING MACHINES, J. G. Fahr, London.
12,941. RELIEVING FLUTED TOOLS, F. G. Echols, London.
12,942. REGISTERING the SPEED of MOTORS, F. Nunns, Halifax.
12,943. VEHICLE WHEELS, R. H. Bicknell, London.
12,944. COVER for BEDROOM CHAMBER, H. J. Heasman, South Woodford, Essex.
12,945. BRAKES, H. Appler, London.
12,946. KNIFE CLEANER and POLISHER, R. Wyatt, London.
12,947. CASE for FUSE BOARDS, J. Bolton, London.
12,948. MASSAGE APPLIANCES, J. H. Powers, London.
12,949. MACHINES for DRESSING FLOORS, C. B. Wattles, London.
12,950. DRIVING MACHINERY LOOP BANDS, F. S. Culver, London.
12,951. SAND BLAST MACHINES, W. R. Lake.—(*A. Gutmann Actien-Gesellschaft für Maschinenbau, Germany.*)
12,952. ROAD SWEEPING MACHINES, Z. Whittemore, London.
12,953. TYPE INKING APPARATUS, J. S. Southerden, London.
12,954. MAGNETIC BRAKES, E. A. Carolan.—(*The General Electric Company, United States.*)
12,955. FLUORESCENT SCREENS, E. A. Carolan.—(*The General Electric Company, United States.*)
12,956. ELECTRIC CIRCUIT CUT-OUTS, E. A. Carolan.—(*The General Electric Company, United States.*)
12,957. MIXING APPARATUS, T. H. D. May, London.
12,958. PNEUMATIC MILKING APPARATUS, A. Gillies, London.
12,959. TYPE-INKING APPARATUS, J. S. Southerden, London.
12,960. PICTURE-BOOK, G. Tuck and T. R. Kennedy, London.
12,961. EDUCATIONAL APPLIANCE, C. Erwin, Kingston-on-Thames.
12,962. HORSE CLIPPERS, H. Mitchell, London.
12,963. KEYS for TYPEWRITERS, J. H. Laudenbach, London.
12,964. MACHINE for GROOVING WOOD, J. Walden, London.
12,965. SILENT KEY MECHANISM for TYPEWRITERS, W. Clark.—(*The Underwood Typewriter Company, United States.*)
12,966. FASTENING for FLEXIBLE BRACELETS, C. Dreyfus, London.
12,967. VARIABLE-SPEED GEARS for CYCLES, R. J. Hine, London.
12,968. PORTABLE ELECTRIC LAMP, P. Schwenke, London.
12,969. TOBACCO CUTTER and HOLDER, W. Silver, Liverpool.
12,970. CONTAINERS for LIQUIDS, J. Thilo, Liverpool.
12,971. STAND for TOOTH BRUSHES, W. Ullrich and S. Feitler, Liverpool.
12,972. BRAID, A. W. Franklin.—(*Kaiser and Dicke, Germany.*)
12,973. DOORS, D. Wickham, London.
12,974. LACE GOODS, F. H. Beer.—(*A. Schönfeld, Germany.*)
12,975. BEATING FIBROUS MATERIALS, W. H. Caldwell, London.
12,976. FURNACES, C. Leistner, London.
12,977. DIVIDING WHEELS for MILLING TEETH, C. Nube, London.
12,978. TARGETS, J. A. Dickie, London.
12,979. DEPOSITING BISCUIT PASTE, A. W. Copland, London.
12,980. MOTOR CYCLE DRIVING GEAR, E. Mercier, London.
12,981. CASH REGISTERS, The National Cash Register Company.—(*The National Cash Register Company, United States.*)
12,982. ELECTRIC CONTACT DEVICES, A. Kuchinka, London.
12,983. MOTOR INSTALLATIONS, Siemens Bros. and Co., Limited.—(*Siemens and Halske Aktien-Gesellschaft, Germany.*)
12,984. DISTILLATION of FATTY ACIDS, V. Sláma, London.

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12,985. AUTOMATIC VOLT REGULATORS, E. Morand, Birmingham.
12,986. REVOLVING CARDING ENGINES, W. Dobson, Wolverhampton.
12,987. SECURING STOPPERS in PIPES, H. Riley, Aberkinfig, Glam.
12,988. SEALING BOTTLES, L. Johnson and J. H. Jefferies, Wolverhampton.
12,989. TRADE VANS and MOTOR CARS, A. Trimmer, Southampton.
12,990. TAPS, T. Bostock, Sheffield.
12,991. VEHICLE SEATS, A. Bull and C. Keatley, Birmingham.
12,992. DISTANCE FINDER, J. A. Gray, Leith.
12,993. CIRCUIT MAKERS, J. G. Statter and C. J. Simeon, London.
12,994. LATCHING BOLTS, C. H. Simkins and C. and W. Hadley, Wolverhampton.
12,995. APPARATUS for DRAWING OFF BEER, S. M. Lund, Keighley.
12,996. CALENDARS, C. L. Jackson and J. Edge, Manchester.
12,997. TAKING STEREOSCOPIC PICTURES, T. Brown, Salisbury.
12,998. SAFETY BUCKLES or CLASPS, A. Liesegang, Manchester.
12,999. AUTOMATIC PLUGS or VALVES, W. Harbinger, South Shields.
13,000. VALVES for ENGINE CYLINDERS, W. A. Ashworth, Manchester.
13,001. MEASURING TANKS for BAKERS, W. J. Woosey, Liverpool.
13,002. BOTTLING MACHINES, J. R. Williams, Manchester.
13,003. WEFT FORK for LOOMS, S. Cook and A. Riley, Manchester.
13,004. VEHICLE BRAKES, R. Bell and R. Maguire, Glasgow.
13,005. APPARATUS for WEIGHING COAL, B. Norton, London.
13,006. INDICATORS for STREET CARS, J. C. Wuerth, London.
13,007. MOTORS, J. Hellwig, London.
13,008. BELTS, G. J. Booth, Manchester.
13,009. ELECTRIC TROLLEY HEADS, J. Major, Manchester.
13,010. OPERATING PRINTING PRESSES, T. W. Barber, London.
13,011. GAS MANUFACTURE, T. G. McEwen and J. A. Curle, Woodford, Essex.
13,012. PROTECTING PAD for JUGS, H. J. Shinkfield, London.
13,013. TABLE KNIFE CLEANER, J. H. Beckelmann, Ilford Essex.
13,014. BEDSTEADS, F. W. Pitfield and T. Goodchild, London.
13,015. COLLARS, R. Whelan, London.

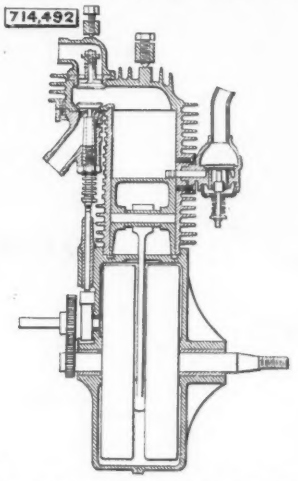
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

714,492. EXPLOSIVE ENGINES, *F. Lagoutte, Asnières, France.—Filed June 26th, 1900.*

Claim.—(1) In an internal combustion motor, the combination of a conduit for exhaust gases leading from the motor cylinder, said conduit having an air inlet near the point of connection to the motor cylinder, valve means controlling the said inlet, valve means controlling the flow of gases through the conduit and located farther from the motor cylinder than the said air inlet, and connecting mechanism, which causes one valve to be open when the other is closed, and *vice versâ*. (2) In an internal combustion motor, the combination of a cylinder having pre-exhaust

714,492

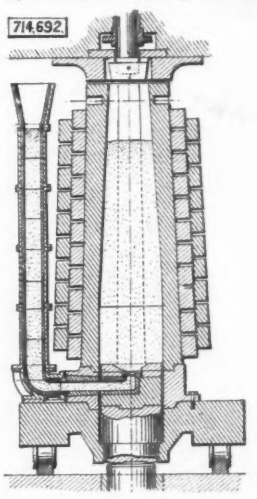


ports located in the side walls thereof, a conduit for exhaust gases connected thereto, an outwardly-opening check valve in said conduit, an air inlet to said conduit located between the connection to the cylinder and the above-described check valve, and a valve which controls said air inlet, said last-mentioned valve being arranged to open only when the first-mentioned check valve is closed.

714,692. PRESS for COMPRESSING LIQUID STEEL IN CONICAL INGOT MOULDS, *H. Harmet, St. Etienne, France.—Filed July 8th, 1902.*

Claim.—In presses for compressing liquid steel in a conical mould, an ingot mould formed in two parts, the ingot mould properly so called and the base, the said base being provided with a lateral passage for the inlet of liquid metal, the said passage coinciding when

714,692

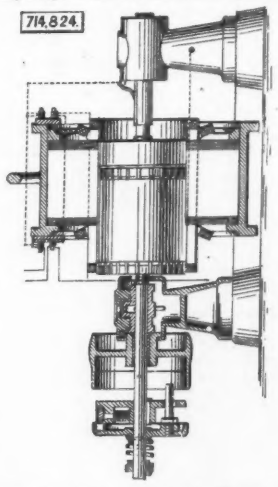


metal is flowing in, with a passage formed in the movable bottom which is housed in the base, the said bottom being capable of upward movement by the action of the press, by which it is actuated at the moment of compression.

714,824. PROCESS of STARTING INDUCTION MOTORS, *A. Schwartz, Cologne, Germany.—Filed March 18th, 1901.*

Claim.—A process of starting induction motors, which consists in pushing the armature out of the field when the field coil is inserted in the circuit, imparting a slight rotation to said armature, whereby the

714,824

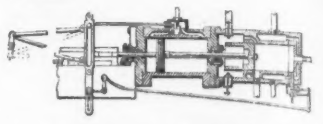


motor may be rotated at its normal speed, then bringing the armature back into the field and automatically operating a clutch device through the movement of the armature, substantially as described.

715,008. STEAM EXPLOSIVE ENGINE, *C. A. Braden, Butler, Pa.—Filed October 19th, 1898.*

Claim.—The combination with a gas engine of a steam engine connected to the latter in alignment therewith and acting when started to reverse the gas engine, a partition separating the cylinders of the two engines and forming one head of each cylinder, the gas engine normally operating independently of the steam engine, an explosion chamber and an exhaust valve chamber in the cylinder of the gas engine, the exhaust valve chamber being of greater diameter than

715,008

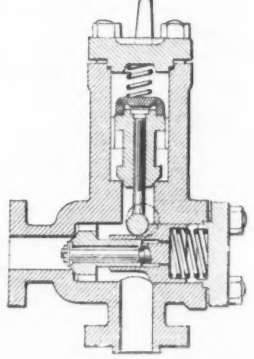


the explosion chamber and in communication through a port therewith, a valve in said exhaust valve chamber, and means connected to the steam engine adapted to operate said valve to exhaust the explosive mixture from the explosion chamber when steam is admitted to the steam cylinder, substantially as described.

715,009. HYDRAULIC OR OTHER FLUID-CONTROLLING VALVE, *H. S. B. Brindley, Tokyo, Japan.—Filed November 26th, 1901.*

Claim.—In hydraulic and other fluid-controlling valves, the combination with an eccentric operating spindle, of independent inlet and exhaust plugs or valves proper and pilots or auxiliary plugs respectively fitted in each of the aforesaid main plugs and

715,009

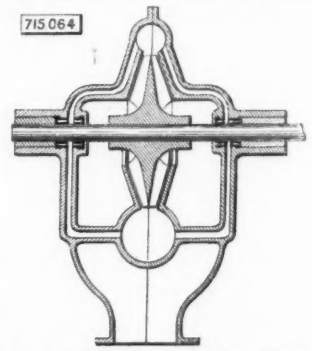


engaging with the said operating spindle, one of the said pilots having a head which abuts against a perforated cap attached to the main plug in which it is fitted, and the other pilot having a head at one end arranged as a guiding and supporting socket for the main plug in which it is fitted and a fixed collar at the other end, substantially as set forth.

715,064. SHAFT BEARING for CENTRIFUGAL PUMPS, *J. Hedlund, Stockholm, Sweden.—Filed June 27th, 1902.*

Claim.—The combination in a centrifugal pump, with the pump-wheel shaft, of a cooling chamber surrounding the shaft at its bearing and provided with two passages connecting it with the pressure chamber

715,064

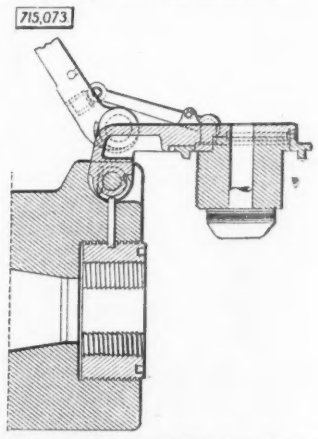


at different points, whereby circulation of the fluid acted upon by the pump will be established through said bearing chamber, substantially as described.

715,073. BREECH MECHANISM for GUNS, *C. Holmström, Glasgow, Scotland.—Filed August 23rd, 1901.*

Claim.—In breech mechanism for guns, the combination with a swinging carrier and means for actuating it, of a cylindrical block provided with a de Bange obturator and non-rotatably mounted on the carrier, and having interrupted threads on its exterior of a rotary bushing having its interior and exterior surfaces parallel, of interrupted threads on the interior

715,073



of said bushing, and continuous threads on the exterior to engage with corresponding threads of the gun, said threads on the interior and exterior surfaces of the bushing being of opposite hand, of a rotary device on the carrier adapted to engage with said rotary bushing when the carrier is swung inward, and of means for angularly shifting said rotary device and through it the rotary bushing so that the block will be moved rectilinearly in said bushing, substantially as and for the purpose specified.

THE CHEMICAL CONGRESS.

(From our own Correspondent.)

No. II.*

Sections IV., V., and VI. dealt with organic products, sugar, and brewing respectively, but the papers read before these sections were of a highly specialised character, and abstracts of them would be of little service to readers of THE ENGINEER. Section IV. alone had 77 papers planned for reading in the two sub-sections into which it was divided, and this figure will give some idea of the immense mass of material provided for the education and edification of the members of this section of the Congress.

Section VII. was devoted to papers on "Agricultural Chemistry," and met under the presidency of Dr. Kellner, of Leipzig. The most interesting paper presented to this section was, in the opinion of many, that read on Wednesday afternoon, June 4th, by Dr. Frank, of Charlottenburg, dealing with "New Methods of Fixation of the Nitrogen of the Air, and its Use in Industry and Agriculture." The author described the principle underlying the newer methods of nitrogen fixation; this being the formation of cyanogen compounds when air is passed over a heated mixture of coke and alkali. The process in which Dr. Frank is interested is a modification of these methods, and consists in the use of calcium carbide with the coke and alkali. When the fixation of nitrogen is carried out under these conditions a compound known as "calcium cyanamide" is formed, and this can be directly utilised for the support of vegetable and plant growth in the soil. Calcium cyanamide contains 14 to 22 per cent. of nitrogen and from 19 to 33 per cent. of pure cyanamide.

In the discussion which followed the reading of this paper Dr. Beddies inquired as to the cost of manufacture of calcium cyanamide, and the author declared that where cheap electric power was available the cost need not exceed that of sodium nitrate or sulphate of ammonia.

Section VIII.—Hygiene, Medical and Pharmaceutical Products, Food Stuffs, met under the presidency of Dr. Merck, of Darmstadt, and was divided into two sub-sections *a* and *b* respectively. Of the fifty-eight papers and reports down for reading before this section only three can receive notice in this account of the proceedings. At the afternoon sitting of Friday, June 5th, Drs. Poskauer and Erlwein presented a joint-paper, entitled "The Sterilisation of Potable Waters by Ozone, and Ozone Waterworks. Dr. Poskauer, in the first half of the paper, stated that "ozone" could replace costly and extensive sand-filters in water works, and enable water engineers to cope with sudden demands for increased water supply. Details of the early trials with ozone for water sterilisation were given—the names of Tindal, Marmier and Abraham, and Siemens and Halske, and the ozonising plants at Leyden, at Liège, at Blankenburg, and at Martinikenfelde being named. The pathogenic results of the treatment of water at the latter ozonising station, erected by Messrs. Siemens and Halske in 1899, were reported on by Doctors Ohnmüller and Krall, and details were given by the author of the methods employed by these investigators to prove the absence of pathogenic germs in the water after treatment at Martinikenfelde. Dr. Erlwein read the second half of the paper, which dealt with the ozone purification and sterilisation water works erected at Schierstein, near Wiesbaden, and at Paderborn. Diagrams and drawings of the plants installed at these two works, and a model of the ozonising apparatus, of the Siemens and Halske type, were exhibited to elucidate this portion of the paper. Interesting details were also given of the automatic safety appliances used to cut off current, or the supply of water and air, in case of breakdown or stoppage in any portion of the plant. The total cost of treatment with ozone by the Siemens and Halske system is estimated to be ·85 pfg. per cubic metre of water, this sum including wages, repairs, depreciation, and interest charges. An interesting and somewhat lively discussion followed the reading of these two papers, and one of the speakers extracted from Dr. Elwein the admission, that the operation of the Schierstein ozonizing plant had been suspended owing to difficulties arising from the presence of iron in the water used in the works.

At the same session of Section VIII. C. Dreyfuss reported upon the methods of sewage treatment that have been tried in Manchester, England, and gave details of the bacteriological system of treatment now used by the city authorities. The plant for the system comprises settling tanks, liquefying tanks, and coke bacterial filters, and the details of its construction and operation are no doubt well known to those of our readers interested in sewage treatment.

Section IX.—(President, Professor Miethe, of the Charlottenburg Technical School), was devoted to papers on "Photographic Chemistry," but none of these were of special interest to engineers.

Section X.—Physical Chemistry and Electro Chemistry, presided over by Dr. Bottinger, of Elberfeld, was the largest section of the Congress, and fully 250 members attended its opening meeting. The meetings of this section were incorporated with the annual meeting of the "German Bunsen Gesellschaft" (the German Society of Electrochemists), and the programme of papers was arranged by the Committee of the latter society. A large number of papers interesting to engineers was read before this section, but only three of these can be specially dealt with.

At the afternoon session of Thursday, June 4th, Professor Henri Moissan, of Paris, read a paper on the "Carbides of the Alkali Metals." After referring to the earlier work of Berthelot and himself on the subject, the author described the first method used by him to obtain carbides of the rarer alkali metals—rubidium and cesium. A thin wire of these metals was embedded in pure lamp-black, and, after removal of the air, the wire was raised to a high temperature by use of the electric current. The combination of metal and carbon occurred with great violence, and on cooling and removal of the excess of lamp-black, a fused compound was found in the centre, which on treatment with water yielded acetylene gas. The decomposition temperature of rubidium and cesium carbides lies, however, very close to their formation temperatures, and it is impossible to obtain a good yield by this method. A better method of production is, therefore, to form the corresponding acetylides ($C_2M_2C_2H_2$) by treatment of cesium and rubidium with ammonia. On heating these crystalline compounds cautiously in a tube from which the air has been removed, acetylene escapes and C_2Cs_2 and C_2Rb_2 are formed. Professor Moissan, in bringing his paper to a close, stated that the carbides of sodium and potassium, if a cheap method of production could be discovered, might have some industrial value in the future, for they yield in treatment with water not only acetylene gas, but also the corresponding alkaline hydrate in place of a waste product.

Following Prof. Moissan, M. Gin, of Paris, read a paper on the "Manufacture of Aluminium." The author, by the use of thermo-chemical data, had calculated anew the E.M.F. required to decompose the various aluminium salts or compounds used in the electrolytic baths for the manufacture of the metal, and had obtained the following figures:—

Al_2F_6, 3·93 V., (or 2·49 V. if the F. be allowed to enter again into combination).
Al_2O_3, 2·19 V.
Al_2S_3, 1·27 V.

The variation between the highest and lowest figures is only equivalent to a power consumption of 5 kilowatt hours; and in the author's opinion the economic problem of the aluminium industry is therefore rather a chemical than an electro-chemical one. The final cost of the product (aluminium) is seen, from the above figures, to depend much less upon the power-factor than upon the cost of the raw material; and the problem of cheapened production rests for solution in the hands of the chemist, not in those of the electrician.

The third paper read before Section X., which may be supposed to have special interest for readers of THE ENGINEER, was by Dr. H. Goldschmidt, of Essen, and dealt with "Steel Manufacture in Electric Furnaces." Seven printed tables of yields and costs relating to the Stassano, Kjellin, and Conley processes were given, and some verbal details of the Stassano Steel Works in Italy—recently visited by the author—were added to the information contained on the tables. The figures for power consumption and cost by the various electric steel processes, were practically the same as those which have already appeared in THE ENGINEER—March 13th, 1903—in the illustrated article upon these processes, and it is unnecessary to repeat them here. In the discussion which followed the reading of Dr. Goldschmidt's paper, the discrepancies between the tabulated costs for the various processes were pointed out, and were explained by Dr. Goldschmidt to be chiefly due to the differences in the raw material used. The author admitted, however, that the electric furnace processes of steel production would not come into competition with the older processes for ordinary types of iron or steel, but in his opinion they had a future for the manufacture of special alloys, or of special steels in which a high degree of purity was required. The refining furnace of Keller will, he thinks, prove of considerable use in this direction.

Section XI. was the statistical and economic science section of the Congress, and dealt with all questions of this character affecting the chemical industries. It had as president Dr. von Martius, one of the members of the Organising Committee for the Congress, and it devoted a large amount of its time to questions relating to patents and trade-mark law. Two of the most interesting papers were upon "The Influence of Cartels and Trusts in the Chemical Industry," and were read by Dr. Scharlach, of Hamburg, and Dr. Simons, of Düsseldorf, at the Saturday morning session of the Section. The author of the first paper argued that no laws could be framed effectively to regulate cartels and trusts, and quoted in proof of the futility of legislation on financial questions, the wide-spread evasion of the regulations of company law.

Moreover, if such legislation could be made effective, the author considered it undesirable for the State to interfere with the internal affairs of the world of industry, and he stated his belief that the cartel system in Germany had contributed greatly to the benefit of the worker, without seriously injuring the consumer. Dr. Simon, in the course of the second paper on this subject, used as his main argument the plea that progress in any industry only occurs when it is flourishing and is paying satisfactory profits. The cartels in German industries contribute to this latter condition of success, and therefore provide one of the essential conditions for real progress and growth. To interfere by legislation with the operation of the cartel system, would be to strike a blow at the development of German industry which might be followed by disastrous results.

In the very lively discussion which followed the reading of these two papers Dr. Goldberger took chief part, and urged several changes in the wording of the resolution upon the subject, which had been submitted by the authors of the papers. Ultimately this was passed by the members of the section present, in the following form:—

"The intervention of the legislature in the matter of Trusts is neither necessary nor desirable.

"The number of different forms in which the coalition of Trusts is brought about, and the variety of objects with which these combinations are connected, would moreover make it appear to be practically impossible to regulate the matter by uniform legislation."

The numerous resolutions framed and passed by Section XI. were brought up for acceptance at the final general meeting of the members of the Congress on Monday, June 8th, but, after a somewhat heated and protracted discussion, it was decided that these resolutions were too important to be accepted without due consideration by all the members of the Congress, and they were therefore referred to the Standing Committee for consideration and report to the Congress of 1905 or 1906. The only resolution of Section XI. which escaped this fate was that dealing with the use of white phosphorus in match-making and other industries. This resolution was accepted in the following form:—

"The Congress considers an international prohibition of the use of white phosphorus in the match-making industry desirable."

In bringing this account of the Fifth International Congress of Applied Chemistry to a close, a few remarks may be advantageously added, regarding the place of meeting, the organisation of the general and sectional meetings, and of the social functions of the Congress. The Reichstag Building was eminently suited for the meetings of the Congress, and the State authorities well deserved the thanks of every member, for their courtesy in placing this building in the hands of the Congress Committee for the week June 2nd to 8th. It will be difficult in Rome or London to find a building so spacious, cool, and admirably adapted in every way, for the meeting of the 1906 or 1909 Congress. The printing and publication of the Congress *Tageblatt*, the daily journal containing the notices for the day, and the reports of the various secretaries on the previous day's work in their sections, was excellent and prompt, and this journal proved of great service in following the proceedings of the Congress. One improvement which might be made is a greater uniformity in the sectional reports. Short abstracts of all the papers and reports should be presented by all the secretaries, and printed in the *Tageblatt*. At Berlin several of the sectional reports were mere enumerations of the papers read, with the names of their authors and those who joined in the discussion; while others were useful abstracts and summaries of the papers and discussions.

Coming now to details of the Congress, which were not well managed, and in which it will be possible to effect considerable improvements at the future meetings in Rome and in London, I must mention the arrangements for ticket distribution on the opening day, the unpunctuality in commencing sectional meetings, and the large number of papers and reports which were allowed to fall out, owing to lack of time for dealing with them.

In all these respects improvements upon the Berlin level of attainment are demanded; and as a condition of success in attaining economy of time, it would be well for those in authority to insist that all papers must be printed, and read *in abstract form only*. This stipulation would prevent members with a well-worn subject, and an easy flow of language, from occupying thirty or forty-five minutes with ideas that they had not even troubled to commit to writing, or with orations containing nothing new. The German is by nature, and by the necessities imposed upon him by his language, inclined to "long-windedness," and this defect is the *bête-noir* of international or other congresses. It would also be well for sectional committees to refuse papers, which are mere *rechauffées* of matter already published and in print. Several of the papers from which I expected to gain much instruction at Berlin were of this description, and the time of the Congress devoted to such papers was practically wasted.

Finally, it may be doubted whether the knowledge of French, German and English is yet so general amongst scientists, that International Congresses can exert their full influence and value.

It is one thing to read a foreign language, and another thing to understand it when it is spoken; and though most scientists can read English, French, and German, their proficiency in these three languages does not yet extend to an equal facility in speaking them, or in understanding them when spoken. The English chemists present at Berlin were handicapped to some extent by this bar to intercourse, and I am certainly safe in asserting that not one of the speeches or papers delivered in English was understood by one-half of those who listened to it. This language difficulty is a further reason for printing beforehand all the papers intended for reading before the sectional meetings; and it is to be hoped that at future congresses some attempt will be made to carry out this regulation.

In time, no doubt, scientists who regularly attend these International Congresses will all become proficient linguists, and will perhaps rival Professor Otto Witt in their command of foreign tongues. Whether the choice of Rome as meeting place for the next Congress will lead to the addition of Italian to the list of official languages remains to be seen; but it would be well for scientists in general, and chemists in particular, to become a little more perfect in their knowledge of the languages—French, German, and English—before they undertake the study of a fourth.

The Berlin Congress of 1903, in spite of the minor shortcomings and disadvantages referred to above, has been a striking success.

Great hospitality has been extended by Berlin to the visitors from other countries, and every effort has been made to make the social side of the Congress a great success. As regards the scientific results of the gathering, there is little doubt that the ideas gained and friendships formed at the Berlin Congress of 1903 will fructify and bear fruit in many industries, and in many lands, and that the more practical work of this great gathering of chemists from all countries, will promote industrial and social progress the wide world over for many years to come.

* No. I. appeared June 19th

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

KESWICK MEETING, 1903.

WE gave a preliminary notice of this meeting in our issue of June 12th. It took place at the Keswick Hotel, Keswick, on Wednesday, June 10th, and the two succeeding days. The president, Sir Lindsay Wood, Bart., was in the chair at the general meeting held on the first day; the other days and part of the first were devoted to excursions.

The papers, except in two cases, were in print, and this facilitated their presentation and discussion at the meeting. Moreover, owing to the absence of the authors, all but four were taken as read. The first paper heard was by Mr. J. Postlethwaite on "The Geology of the English Lake District," in which an interesting review is given of the past and present position, character, and relations of the rocks of the district, which the author agress with others consist of a centre of Lower Palæozoic rocks, surrounded by a girdle of carboniferous strata, which in turn are bounded by Permian and Triassic beds, and there are volcanic rocks. The latter give the Shap granite and the Threlkeld quartz-felsites, the coal measures the wealth of coal, whilst a narrow strip of carboniferous limestone in West Cumberland, extending northwards from Egremont about eight or nine miles, and measuring from one to one and a-half miles in width, has been, and is still, a repository of vast mineral wealth. The deposits of hematite in the area here described are of immense value. Similarly rich deposits also occur in the carboniferous limestone in South Cumberland, near the mouth of the Duddon Estuary, at Hodbarrow and Whicham mines; indeed, the output at the former probably exceeds that of any mine in Cumberland. Equally rich deposits occur in connection with the carboniferous rocks of Low Furness. The deposits here are very irregular, but the largest masses of ore are found at or near the junction of the slate rocks and the carboniferous limestone. The Permians yield the St. Bees sandstone; whilst mineral veins of irregular contents and insignificant extent are numerous in the Skiddaw slate rock, in the volcanic rocks they are less numerous, but have been more productive, more persistent and more extensive, but the most valuable metalliferous deposits occur in the carboniferous limestone.

Mr. Geo. H. Bragg followed with a paper on "Granite Quarrying, Sett Making, and Crushing; and the Manufacture of Concrete Flags and Granite Tiles." The subject matter referred to the Threlkeld quarries which the members had visited earlier in the day. The sites of the quarries, of which there are two main ones, were selected to get the advantage of the joints. In Threlkeld these are numerous and irregular, consequently the rock does not break away in large pieces, so is not useful for construction work but is excellent for setts and road metal. Gunpowder has been found superior to either dynamite, gelatine, roburite, or ammonite for blasting; the average result in these quarries is 458 tons of rock per 100 lb. of gunpowder employed. For heavy blasting, holes are bored 3in. in diameter to any desired depth up to 20ft. or 25ft. A few years back this work was done by hand, but the superiority of power drills is so decided that they are now used. In fact, Mr. Bragg remarks that there is scarcely any plant that will sooner repay any reasonable expenditure than air compressors and machine drills at large quarries and similar work. The time wasted by hand drilling is enormous, and the output is considerably retarded, as it will take two men one and a-half days to drill a hole 2½in. in diameter to a depth of 10ft., while it can be bored by a machine in one and a-half hours. By the latter means, more rock can thus be dislodged in a given time in the quarry where the working face or front is limited in extent. Hand-drilled holes also lose much in gauge or diameter; the hole will be commenced with a tool of 2½in. gauge, and finish at 1½in. gauge at a depth of 8ft. or 10ft., whereas machine drills start with a tool of 3½in. gauge, and finish with 3in. at a depth of 20ft. with a round hole. It will, therefore, be readily understood that the explosive is used with marked advantage in larger holes, and will dislodge considerably more rock. Generally speaking, it has been found that the saving effected by the use of machine drills amounts to at least £18 per 1000 tons of rock quarried.

In this rock × bits are used, and where possible chisel bits, but + bits produce oval holes. Compressed air is the power preferred to both steam and electricity for driving the drills. The drilled holes are cleaned out with hay and fine granite dust, charged with powder in the usual way and stemmed with granite dust. The height of the quarry face is not allowed to exceed 60ft., and where that height is attained another level is started, and to prevent anything falling on the men, work in the lower level is stopped until a floor of 30ft. is cleared on the new level. Larger blocks are used for sett making, which is done by hand. Experiments in sawing setts mechanically have not proved economical. The smaller stuff and lumps pass to the mill and are broken up in Blake-Marsden stone-breakers followed by knobbed rolls, which effectively cube the broken granite into macadam. All the material then falls into a revolving screen, 30ft. in length by 4½ft. in diameter, which sorts out the various sizes as follows:—½in. mesh, with proportion of fine sand used for mortar and plastering; ½in. mesh, with proportion of fine sand used for concreting; ¾in. mesh, used for topping asphalt and tar-macadam roads; ¾in. to 1½in. mesh, used for tar-macadam and railway ballast; and 1½in. to 2½in. mesh, used for general macadamising. All stones passing along the screen which are too large for the holes 2½in. in diameter, and called "rejectors" or "tailings," are elevated by buckets on to a conveyor 2ft. in width, and carried back again to the cubing rolls. The proportion of fine material up to ½in. mesh is generally about 18 per cent. of the total quantity of stone crushed; plain surfaced rolls yield about 6 per cent. more fines than knobbed rolls. The output is about 110,000 tons per annum. All this material is run down inclined tramways, 2ft. 4in. gauge and 1 in 12 gradient, in 1 ton capacity tubs to the sidings, where it is tipped by tumblers into railway wagons. The works are provided with siding and wharf accommodation for 200 private 10-ton wagons, which are all rebuilt or repaired on the premises. Concrete flags, window-sills, heads, jambs, steps, &c., are also made at Threlkeld.

The process is described by the author as follows:—

The aggregate, consisting of ⅜in. crushed granite with a small proportion of fine, is run in tubs direct from the crushing machines into these buildings, where it is elevated in buckets into a hopper, placed above the mixing platform, to facilitate the measuring in boxes of proper dimensions. The requisite proportion of Portland cement is then added, and all is thoroughly turned over and mixed in a dry state with a three-pronged fork. This material is then introduced into a square mixer, with tubular projections, where it receives the necessary quantity of water—about 22 gallons per cubic yard of concrete. On emerging from the mixer the concrete is lifted by hand into moulds placed on a vibratory table, which not only efficiently and quickly consolidates the material, but thoroughly expels any air bubbles, which rise to the top and disperse. The moulds, made of timber and lined with zinc, give a perfectly smooth face to the flags; and before being filled the bottoms of the moulds are rubbed with an oily concoction to prevent the cement from adhering to them. After filling, the moulds are transported on bogies along the floor of the building, where they are stacked in tiers, and accurately levelled and trowelled on the surface before the concrete has had time to set. The flags are allowed to remain at least four to five days before they are discharged from the moulds and placed in the open air to mature for at least twelve weeks. Under the method just described the material retains every particle of cement originally introduced into it, and owing to the well-known property of cement, all superfluous moisture is thrown off after it has taken up what it requires.

The plant at Threlkeld can produce over 3000 superficial yards 2⅛in. and 2½in. thick weekly.

Another interesting and attractive department is the factory for coloured granitic tiles. The colours are thoroughly incorporated in a ball mill with Portland cement and are sifted into steel moulds through stencil plates of the right pattern, a sheet zinc cover with openings only for the colour in use prevents any mixing of the colours. The cement colours are placed in about ¼in. deep, the mould is filled up with granite-sand and cement, and subjected to a pressure of one ton per square inch. The tiles are mechanically ejected from the mould, placed on a shelf, and in a few hours are treated with a solution for fixing the colours. Then they are moistened from time to time, and finally immersed in a tank of water for some time. The various operations had been followed with much interest during the visit.

Mr. William Leck, H.M. Inspector of Mines, followed, and said a few words advocating "Ambulance Instruction at Mines."

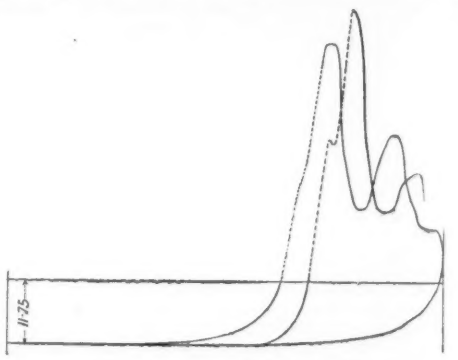
Then Mr. David Burns read his paper on "The Gypsum of the Eden Valley," in which he pointed out that that mineral was being exploited at Cocklakes, Cotehill, and between Lazonby and Salkeld in Cumberland, and near Temple Sowerby and Newbiggin in Westmoreland. In 1901 Eden Valley produced 26,655 tons out of a total of 200,766 tons for the United Kingdom. The other papers have already been referred to. Thirlmere was also visited on the Wednesday.

On Thursday, June 11th, the first visit was to St. Helens—Pit No. 3 of the St. Helens Colliery and Brickworks Company, Limited, near Workington. Here a new colliery is being installed on the site of an old one. The old upcast is used for drawing water; at it there was an old Cornish pump and a quaint horizontal engine seventy or eighty years old, with most of the old parts still in use. The new shaft is 17ft. in diameter, is walled with moulded blocks; it is intended to draw 1000 tons a day. Both shafts are connected by rope haulage roads and inclines with one another and with a Coppée washer of 500 tons a day capacity also in course of erection, and a monumental structure in its unfinished state. So here will be screening plant for separating round coal, and a washery for various sizes and coking coal. It promises to be a fine colliery. St. Helens pit No. 2 was next visited, equipped with local-made winding engines, also haulage engines and air compressors. Here too is a Coppée washer, and, what was interesting, vibrometer screens, which are found superior to all others tried, for although at first one large one was used without success, the two smaller ones now in use have given great satisfaction. Another feature of these collieries is the compact electric installations for lighting purposes which have been running continuously for over eight years. Steam is obtained from Lancashire and Babcock and Willcox boilers. Some light refreshments were enjoyed, and the party left for the Derwent Iron and Steel Works belonging to Messrs. Charles Cammell and Company, Limited. The excellent running and the easy handling of a large volume of work excited the admiration of the visitors. There are five blast furnaces with their stoves, and ore, flux and coke bins on one side, and pig beds on the other; beyond is a range of seventeen boilers, fired with blast-furnace gas, also a battery of self-stoking Babcock and Wilcox boilers with men busily engaged in charging the hoppers, but nevertheless the excellent effect of mechanical stoking was evident and then the great vertical blowing engines, in a suitable majestic building. Next a line of ten converters, eight for rail steel, two for fish-plates, where any operation connected with Bessemerising can be seen at any time, for while one is pouring another is blowing, another receiving additions, and another being charged, presenting a striking and interesting spectacle. There are five semi-circular casting pits. In the adjoining immense structure are two rail mills and a fish-plate mill, the ingots are transferred by locomotive crane and hand to re-heating furnaces. The rolls are arranged in three groups, one in front of the other; the progress from one group to the other is very easy, and the rail is completed from the ingot in one heat; 120 lb. rails can be rolled, but 85 lb. rails were passing through. All engines are reversing engines. There are live rollers on each side of the rolls, and lifting tables at the three-high stands. The fish-plate mill proved very attractive, sawing the hot bar, shaping in presses, punching, dressing, and dipping being eagerly followed. Beyond the mill is the great hot-bank for the temporary storage and finishing of the rails. The output was put down variously at 5000 to 7000 tons, including 450 tons of fishplates; the blast furnaces furnish 4000 tons of pig, and the remainder is obtained from the company's furnaces at Maryport, and in the open market. The visit terminated, as it seems customary in West Cumberland, with light refreshments, and after another luncheon the party left Workington for Whitehaven.

THE MARS VERTICAL DISPLACEMENT AIR PUMP.

THE accompanying engravings, page 639, illustrate Thomas and Marsland's patent condensing plant as manufactured at the firm's works, Ovenden, Halifax.

The principle on which this pump is constructed is that there is a sufficient head of water to ensure the water being always in contact with the bucket, thereby enabling the pump to be run at a high velocity, consequently reducing the diameter of the barrel and size of the apparatus generally. The other advantages claimed for the system are obvious. The bucket valves are eliminated, and the foot valves in the bottom of the condenser are placed in such a manner as to prevent any possibility of waterlogging, and are in every way easy of access. Again, the tendency to air lock is obviated, owing to the fact that on the bucket being at the bottom of its stroke, the valves at the bottom of the condenser open, allowing the condensed water and vapour to pass into the air-pump chamber, and on the return stroke the bucket displaces the water, which effectually discharges all

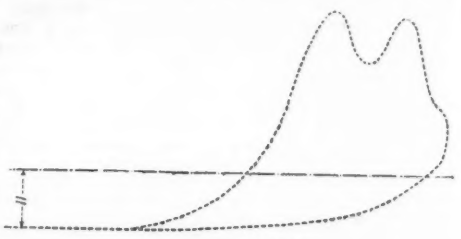


AIR PUMP DIAGRAM

air and vapour suspended above its surface, and also the condensed water. The relative position of the air and water remains unchanged, which overcomes any aëration which is so pronounced in the old type of pump.

The makers inform us that they have for some time past been investigating the question of air pumps with regard to maintaining an efficient vacuum at a high bucket velocity, when working against a considerable head of water. With this end in view, they constructed a small air pump, which is independently driven, and which condenses the steam from a single-cylinder engine of some 70 indicated horse-power. Although the conditions under which the pump is worked are not good—owing to a very limited supply of injection water—they have succeeded in maintaining a vacuum of 24in. in the condenser, with the barometer standing at 28·7in., the temperature of the ejection water being 105 deg., the injection water level being 16ft. below the pump, and the tank into which the ejection water was discharged 25ft. above; the total distance through which the water has to be passed is some 40ft. This they have succeeded in doing with the pump running at 100 revolutions without the slightest shock.

We give two diagrams taken from the small independent jet condensing plant. Up to the present the makers have



AIR PUMP DIAGRAM

had no opportunity of ascertaining the amount of steam passing through the engine, which is of the single-cylinder type (14in. diameter by 2ft. 6in. stroke, making about 100 revolutions per minute), but by calculation of the diagrams, and careful observation of the water gauge on the boiler, they are of opinion that 2000 lb. of steam are dealt with per hour.

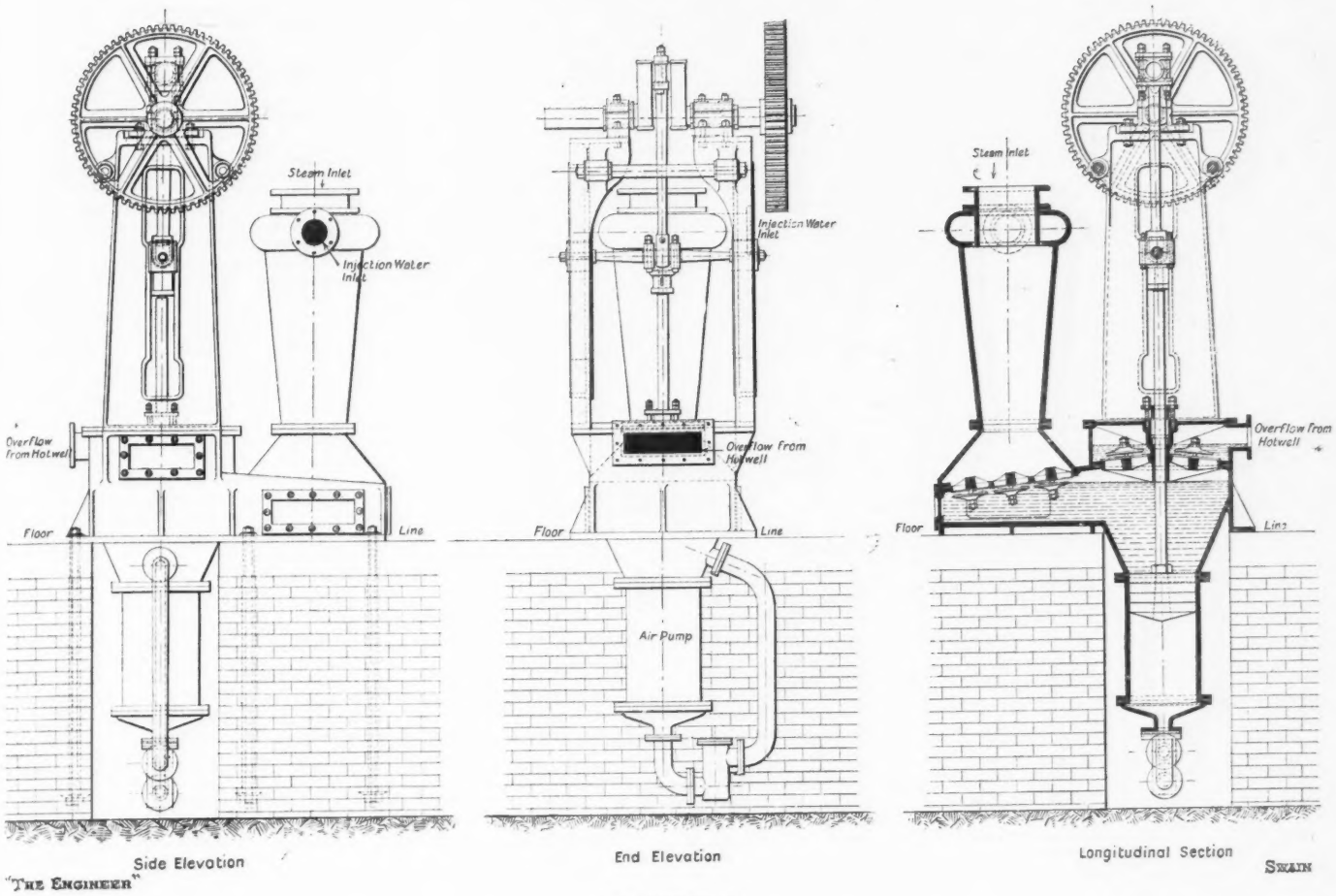
The air pump is 7in. diameter, by 15in. stroke, and is geared to run about the same speed as the engine, consequently the ratio of the air pump to the cylinder is about one-eighth instead of the usual proportion of one-sixth.

It will be seen from the diagrams that the greatest momentary pressure comes when the pump is running at the slower speed. The only explanation we can give of this is that the head of water on the delivery side of the pump becomes more accelerated, owing to the more numerous pulsations, and consequently, by its acquired momentum, has a tendency to reduce any sudden momentary pressure. An examination of the diagram taken at the higher speed reveals the fact that considerably more power has to be expended on the working of the pump; this may be accounted for by the greater weight of steam, and consequently a much greater supply of injection water having to be put through the condenser.

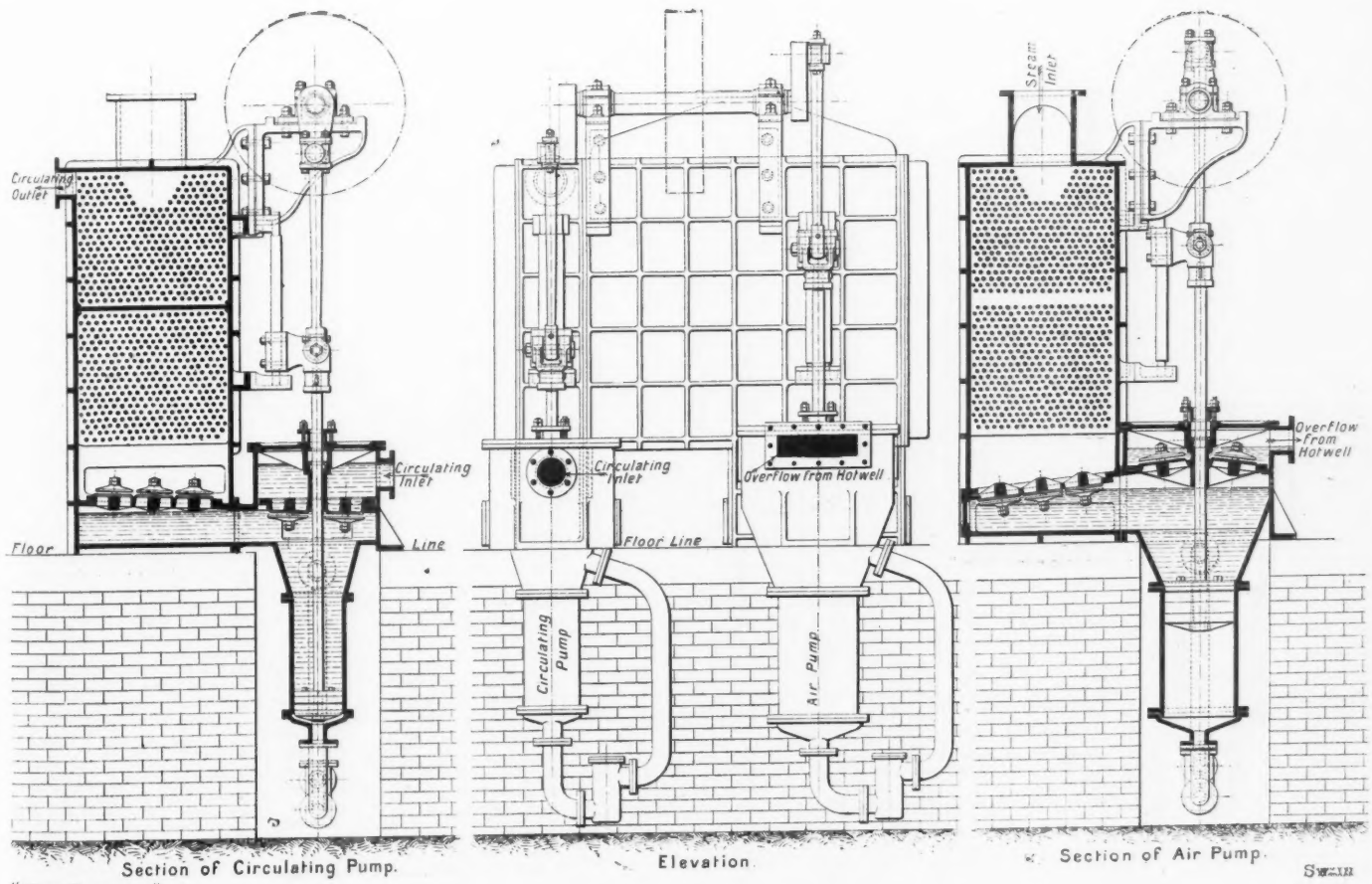
INDEPENDENT AIR PUMPS AND CONDENSERS

THOMAS AND MARSLAND, OVENDEN, HALIFAX, ENGINEERS

(For description see page 638.)



JET CONDENSER



SURFACE CONDENSER

THE INSTITUTION OF CIVIL ENGINEERS.

ENGINEERING CONFERENCE, 1903.

On Thursday, June 18th, the second day, Section I. met in the Hall of the Institution of Mechanical Engineers, Sir Guilford Molesworth in the chair. The first paper read was by Lieut.-Col. Yorke, R.E., on

"THE ORGANISATION AND ADMINISTRATION OF AN AMERICAN RAILWAY."

The ownership of a railway in America is, as in this country, vested in the shareholders, who exercise their control through a board of directors, with a chairman at their head; but, as is well known, these do not play a very important part in the management.

The directors elect a president, who is the chief executive officer, and exercises all the real powers of control and direction. Frequently the president is also chairman. It is interesting to note that the president is sometimes an engineer; for instance, President Cassatt, of the Pennsylvania Railroad, the most important line in the States, is an engineer; so also are President Ramsey of the Wabash Railway, President Loree of the Baltimore and Ohio Railway, and President Burt of the Union Pacific Railway, and in addition to these several vice-presidents are engineers. In fact, engineers seem to have larger opportunities for advancement in this direction in America than in England. Or perhaps I should say that ability obtains more speedy recognition.

The president's authority is supreme, and his brain and intelligence direct the entire concern. In this way is obtained that personal control, which, when the man is worthy of his position, is productive of brilliant results. The president is assisted by a number of vice-presidents, each of whom supervises one of the departments into which the administration is divided.

The principal departments are usually the following:—Law department, treasury department, traffic department, operating department, but sometimes there are more. The functions of these departments are sufficiently defined by their names, the only ones to which it is necessary to draw attention being the two last-named. The traffic department has charge of the passenger and freight traffic, the tariffs, the interchange of business with other railways, and the commercial relations with the public. The operating department has charge of the construction and maintenance of the railway, its equipment, the trains and stations, and of the *personnel* and discipline of the service. The interesting feature here is the separation of the traffic or commercial duties from the operating or working duties. This arrangement is contrary to English practice, which combines the duties of the two into one department, called the traffic department. The North-Eastern Railway, and, I believe, the Great Northern Railway, have recently adopted an organisation similar to the American practice in this respect, and it will be very instructive to learn the results.

The advantage of this separation can, I submit, hardly be doubted. The operating department has charge of all the physical resources employed in the safe and economical movement of goods and passengers. It is the life and soul of the whole organisation, and upon its vitality and the healthy performance of its duties depends the very existence of the railway. Its responsibilities are so vast, and the demands upon its activity so constant, that it seems sound policy to relieve it of all anxieties which are not strictly connected with the movement of traffic. The operating department is, I suggest, somewhat in the position of the works manager of a large manufacturing concern, whose duty it is to produce a certain article at the most economical rate and as rapidly as possible consistently with good workmanship. The operating department has to supply transportation at the lowest possible rate and in the most efficient manner. The traffic department, on the other hand, resembles the selling agent of the manufactory. It sells the article produced by the other, viz., transportation, at the best possible price obtainable. It watches competitive concerns, makes and enforces rates for goods and passengers, builds up the business, and transacts all negotiations with other railways and with the public.

I propose within the time at my disposal to deal chiefly with the operating department. This is under the immediate direction of the general manager, and is divided into:—The road department, the machinery department, the transportation department. The general manager may be under a vice-president, but in some cases the general manager is the vice-president. I would say here that the organisation I am putting before you is typical of that employed upon a fairly large railway, and it is liable to variation according to circumstances. For instance, sometimes the traffic department is under the general manager, although still distinct from the operating department; in others it is under a separate officer or vice-president. In very large organisations there may be two or three general managers, each with his own territory, in which case there would be a vice-president over them all.

The road department is in charge of the chief engineer, the machinery department is under the superintendent of motive-power, and the transportation department is under the general superintendent, all of whom report to the general manager. The chief engineer has a large staff of assistants at head-quarters, including engineers for new works, an engineer for bridges and buildings, an engineer for maintenance of way, and a signal engineer. The superintendent of motive-power has under him a mechanical engineer, who is in charge of the drawing-office and of all standards and details, and two assistants, one for engines and the other for cars. The general superintendent has one or more assistant general superintendents, a superintendent of transportation, a superintendent of telegraphs, besides a chief surgeon, a chief claim agent, and a chief of police.

When a railway exceeds 300 miles in length, it is divided into divisions, which, in thickly populated districts, do not usually cover more than 100 miles, each division being under the control of a divisional superintendent, in whom is focussed the authority of each of the general officers already mentioned. The divisional superintendents, in fact, become the general managers of their divisions. The divisional superintendents report to and receive orders from the general superintendent. All orders to the officers of the road and machinery departments should pass through them. And although, to save time, communications may pass, for example, from the chief engineer to the divisional engineer, the divisional superintendents are responsible for the execution of all orders and for the discipline of the men of all departments in their divisions. Each divisional superintendent has to assist him a staff consisting of a train-master, in charge of the transportation service; a master mechanic, in charge of the machinery service; and a divisional engineer, or, as he is frequently called, a road-master, in charge of the affairs of the road department.

The division officers are in immediate charge of the operation of the train service and of the maintenance of the road bed and track, the signals, bridges, buildings, locomotives, car-shops, and engine-houses. It is their business to see that the work is carried out according to the policy adopted by the management. It is not their concern whether the policy be wise or not, nor are they responsible for the results, except so far as these are dependent upon the efficient performance of their duties.

The divisional engineer is assisted by several supervisors, viz., of track, bridges and buildings, signals, waterworks, &c. The master mechanic is assisted by a general foreman of the shops, in which there are other foremen in immediate charge of the fitters, boiler-makers, carpenters, and other workmen. He also has under him a foreman of the engine-house, in charge of the locomotives and their running repairs, and of the enginemen and firemen so far as their mechanical duties are concerned.

The train-master has charge of the train service. He has jurisdiction over the stations and yards, and of the road in the division, and over the train crews and engine crews while on the road. He must give special attention to the weight and tonnage of the freight trains, and see that the locomotives are loaded to their full capacity. He is assisted by a chief train despatcher, who is in direct charge of the train movements, of the telegraph lines and operators, and of the office records. He has also under him the yard masters and station agents.

When a train starts out on the road, its movement is watched day and night by the operators at every telegraph office, and the time every train passes every station is telegraphed to the train despatcher, who enters the time on the train register. At each station is displayed a special form of signal known as the train order signal, by which a train is stopped by the orders of the despatcher, who thereby controls the movements of all trains. The running of regular trains is, as a rule, governed by the time-table; if, however, they get out of course, the assistance of the despatcher is needed. Extra trains are entirely dependent on the despatcher. The system of train orders is elaborate, there being no less than thirteen different standard forms of such orders, but time does not permit me to go into this detail of American practice and its results.

The paper was supplemented by a "chart," which resembles a genealogical tree, with the president at the top. We have not thought it necessary to reproduce this.

The discussion was commenced by Mr. Berry, general manager Great Northern Railway, who said that he had the advantage of being trained as an engineer. Last year they had divided the operative from the commercial departments of traffic. The first had to do with the whole of the work of loading—moving the loads, shunting, even to the final loading into carts, of all descriptions of goods. The commercial department looked out for orders, interviewed traders, and so on. The new system came into use last August, and the results had been very satisfactory. One great advantage of reorganisation had been that the repairs of locomotives were all concentrated at Doncaster, and the district repair shops were being converted into running sheds. This effected a very appreciable economy. The train despatcher was not wanted and could not be used in this country. The places of the numerous vice-presidents, referred to by Colonel Yorke, were in this country filled by small committees. This country was too little for a multitude of vice-presidents. When he was in Buenos Ayres, in charge of a railway 800 miles long, it was absolutely necessary to have a vice-president at the remote end. The conditions of climate were such that contingencies might occur at any moment that must be dealt with on the spot, without reference to headquarters.

Mr. Gibb, the general manager of the North-Eastern Railway, spoke at considerable length about the conditions that make for economy. It was, he said, a sign of the times that they should be discussing railway organisation. That was the supreme factor. When a manager was puzzled, when he found something going wrong, he knew not what, a leak through which money was wasted, or something that prevented money being made, let him examine the organisation. If that were all right all would go well. In few words, to cure an evil improve organisation. Colonel Yorke, having been in the United States, had come home greatly impressed with the organisation he had seen. He—Mr. Gibb—was not surprised. In all cases there must first be a supreme head; secondly, departmental heads, few in number; and, thirdly, the minor heads of every department. It was a curious feature in the chart given by Colonel Yorke that the accountant did not appear. That was a little significant; but it was right to omit him, because he was not concerned in working a railway; he was merely a recorder. Now, nothing was more striking in America than the use made of the recorder's work—that is to say, of the statistics collected in the accountant's department. It is in this that success lies; with these figures all hands grasp the meaning of what is being done, and the cause of weakness or of strength can be at once fixed upon. It is most important and logical that the operating and commercial departments should be kept distinct. It is, however, essential that the best man should be got to manage each. No one man can do both as it ought to be done. In some cases, although the general truth of this was recognised, the mistake was made of keeping the control of goods warehouses in the hands of goods managers. That was wrong. The control of all loading work should be in the hands of the operative department. As to the men, it should always be kept in mind that individuals must be found to fit the system. The system must not be made to fit individuals. The superintendent of the operating department ought to be an engineer. The higher organisation required a good thinking staff at the top. The work to be done was very exhausting, and care should be taken that the heads of departments were not worried with correspondence and details that could just as well be managed by others.

Mr. Phillips, manager of the North Staffordshire Railway, said that he had been general manager for twenty years. He sketched his life, and showed how he had gradually risen to his present position. The first thing he did when he got control was to separate the operating from the commercial departments. He did not agree with Mr. Gibb, however, that it was wise to take the warehouse out of the hands of the goods agent, who, if he was the right man, possessed a great deal of most valuable local knowledge, and would bring personal influence to bear on traders.

Mr. Cuningham, Central London Railway, spoke of the Vanderbilt system, and criticised the argument of Mr. Taber. In the States the general manager was a king.

Mr. Jacomb Hood, London and South-Western, said that he had the advantage of having worked on railways both in this country and America. A great defect here is that all training is specialised, whereas in the United States a common training is given to all railway men. The result is that there is a thorough all-round grasp of the work to be done, a universality of competence which does not exist here. With us the defect is that no one knows or troubles himself to know what the next man does. The result is a total lack of harmony, and disputes. The country is far too small to carry a multiplicity of general managers; and for the rest it was far better to report to one man than to a small committee of amateurs. It was most important that the maintenance of a railway should be under the control of one man, who must be under the general superintendent, and carefully trained for his work.

Mr. Robinson said that the great thing to avoid is departmentalisation. In India that had done much harm. He gave as an instance a case which came under his own notice. He found that on a certain road the engineer was laying imported sleepers, which he had to carry 1000 miles from the port of entry. He was asked why he did not use native timber, which could be had on the spot, and replied that he could buy the imported sleepers for less money. But he had quite forgotten that to carry the sleepers 1000 miles cost much money. He saved £100 in his own department at the expense of about £1000 in the traffic department. As an instance of the value of statistics, he said that he found the average engine load 200 tons of goods. There was a demand for more engines, so he had the arrangements revised, special fast goods trains knocked off, and so on, with the result that he brought up the train loads to the very respectable figure of 240 tons, and no fewer than seventy locomotives were saved in mileage.

Sir Guilford Molesworth, speaking as a practical engineer, said that it was an utter mistake to try and make engineers commercial men. They loathed accounts. He never ceased to impress on the Government of India the necessity for relieving engineers of purely commercial work. As for the train despatcher, he answered very well for single line work, but he was worse than useless for double lines.

Lieut.-Colonel Yorke replied in a few words. It would be a mistake to suppose that he advocated the train despatcher. In the United States vast quantities of statistics were stored for future use. He purposely omitted the accountant's department, which had nothing to do with the working of a railway. He got the chart from a paper by Mr. A. W. Sullivan. There was far too much of the water-tight departmentalism in this country.

The second paper read was by Mr. S. B. Cottrell, on

"THE RELATIVE ADVANTAGES OF OVERHEAD, DEEP LEVEL, AND SHALLOW SUBWAY LINES, FOR THE ACCOMMODATION OF URBAN RAILWAY TRAFFIC."

The question of rapid means of communication in large towns has been for a considerable period demanding very serious consideration, and the solution of the problem becomes daily more necessary.

The congestion of traffic in the streets of many great towns has become such as to make rapid transit impossible, and it is necessary to relieve the streets of passenger traffic to make them available for the carting traffic. In numerous towns the congestion on the streets is so great that the passenger and light traffic so impedes the heavy cart traffic as to add considerably to the cost of conveying merchandise to the points where it is required; therefore busy streets should, as far as possible, be relieved of passenger traffic requiring to travel any considerable distance. The means of doing this is either by overhead railways or by deep-level or shallow subways, all of which possess their particular advantages and disadvantages.

Overhead railways.—The author has had many years' experience of working an overhead railway—viz, the Liverpool Overhead Railway, which is the only overhead railway in England, and was the first overhead railway in the world to be worked by electricity.

Overhead railways possess among other advantages the feature that the passengers are always in the open, rendering travelling more pleasant. In Liverpool the overhead railway has solved the problem of urban communication along the line of docks. The disadvantages of overhead railways are that to be built economically they must necessarily be of a somewhat unsightly character, and in the author's opinion they would not be permitted in this country as they are in New York, Boston, Chicago, &c., along important public streets. In fact, the compensation that would have to be paid for obstruction to light, &c., would render their cost prohibitive.

Deep-level railways.—Deep-level railways have the advantage that they can be constructed without interfering with the sewers, gas pipes, &c., with which all busy streets in important towns are necessarily so full, and there are many instances of such railways in London doing useful work, such as the Central London and the City and South London Railways, which, although the cost of construction was very high, are yet able to pay a dividend; but it must be remembered that at the present time neither of the railways referred to has efficient surface competition.

In the author's opinion, in the interests of the public the tubes for such lines should be not less than 13ft. 6in. in diameter.

The disadvantage of these deep-level railways is the time occupied in descending by means of lifts to the platform level. For short distances, if there be taken into account the time of descending in lifts, traversing a foot subway and waiting for a train, even if only one minute or two minutes—this operation being reversed at the point of arrival—the time so occupied does away with the advantages of the rapid transit between the points selected, and therefore any keen surface competition, such as by electric tramways, would seriously decrease the earning powers of these deep-level subways.

Another drawback of deep-level subways is due to the question of ventilation, which in existing tube railways leaves much to be desired.

Shallow subways.—The special advantage of shallow railway subways is that passengers can reach the trains without the necessity for using lifts and foot subways; therefore they enjoy the advantages of rapid transit from point to point without the waste of time required in descending to a deep level.

The author spent considerable time in making himself acquainted with the shallow subway at Buda Pest, and although this subway has surface competition, the fact that passengers can reach the trains by descending a few steps only, and the advantages of rapid transit, enable this electric railway to be a financial success.

The Paris Metropolitan Railway, which is also a shallow subway, has had the effect of relieving the streets of a large number of omnibuses, and has rendered them available for other purposes. This railway also is a commercial success.

In the author's opinion, the fact that the Metropolitan and Metropolitan District Railways are what may be almost described as shallow subways is one of their "assets," and when these railways are electrified they will enter upon a new era of prosperity in spite of other competition.

Another great advantage possessed by shallow subways is that the ventilation is very much easier than in deep-level subways. They may be described as self-ventilating.

The disadvantage of shallow subways is that in this country, below the surface of the streets—where shallow subways are required to relieve the congestion—there is encountered such a haphazard accumulation of sewers, gas and water pipes, telegraph and telephone mains, and electric light cables as to render the construction of shallow subways very expensive, owing to the necessity for diverting these obstructions. Yet if the local authorities, telephone companies, post-office, &c., would meet the promoters of shallow subways, and make another subway to contain their sewers, pipes, wires, &c., the result would be to the advantage of all.

The author therefore advocates, for the accommodation of urban

railway traffic:—(1) Overhead railways, if they can be constructed to meet the requirements, in back streets, where compensation would be immaterial and their unsightly appearance would not be objectionable; (2) shallow subways where they can be constructed and the cost is not prohibitive; (3) deep-level railways.

The author has assumed in all these cases that the operation of the railways would be by electricity. Deep-level railways would be commercially impossible if worked by steam, and shallow subways so worked are undesirable. Overhead railways are, of the three systems dealt with, the only ones that could be commercially worked by steam, but for urban traffic steam is undesirable. Electric traction has the advantage, not only of being more desirable, but also—for rapid and frequent transit—the solution of the problem of urban railway traffic—of being more economical.

The discussion was opened by Mr. Galbraith, who said that everyone was agreed that it was better to travel in the open air than in any kind of tube or tunnel. The Liverpool Overhead Railway was quite exceptional. It ran through private property, and served the docks admirably, but it was of no use as a precedent for general urban railways. He had been associated with the late Mr. Greathead in the construction of the Waterloo and City Railway. The tube was 12ft. in diameter. It was a great improvement on the 10ft. of the City and South London. The public did not understand the question. They did not see the benefits conferred by the larger dimension, and when asked for capital said that the City and South London was a success. Why make the tube bigger? The Central London Railway was 11ft. 6in., which was too small. All the group of lines in the hands of Mr. Yerkes would be 11ft. 6in. They ought to have 12ft. 6in. to 13ft. The larger diameter became of increased importance and value when the electric locomotive was given up and motor trains were used, because room had to be found at the end of the car for the motor, and they raised the floor in such a way that it was very difficult to provide an emergency end exit. The great feature about deep-level tubes was that they did not interfere with the streets during construction. Take the Baker-street and Charing Cross line, for example; there was scarcely any cartage of spoil through the streets, it was all delivered in the river. He then proceeded to consider at some length the relative value of various proposals for urban lines, arriving at the unavoidable conclusion that the deep-level tube was the only available solution of a very difficult problem. We have referred more fully to the whole question in another page, and therefore we need say no more of Mr. Galbraith's valuable contribution to our knowledge of the subject except to say that he holds that it is only necessary to push the workman's cheap fare system a little further to prevent such lines as the Central London from being worked at any profit whatever. If this result is once brought about it will effectually stop the investment of money in this direction.

Mr. Thwaite laid on the table two large albums containing photographs of the moving footway at the Paris Exhibition, which worked for two hundred days without an accident, and carried 60,000 persons per day. The Rapid Transit Commission of New York had now before them a proposal for putting into a subway three lines, with speeds of five, ten, and fifteen miles an hour. He held that this would solve the whole question.

Mr. Beard, dealing with the overhead railway, said that the great thing to do was to get rid of the deck, which, added to the cost, weight, and noise, besides making for unsightliness. He suggested that the Elberfeld suspended railway was well deserving of consideration for adoption in cities like London.

Mr. Cuningham, general manager of the Central London Railway, criticised overhead railways, and maintained that they could not be used in the metropolis. The shallow subway could not be constructed, because of the vast network of pipes and wires under the streets. The deep tube was the only solution of the problem. As to ventilation, the shallow tube was not a bit better than the deep tube. They had only to refer to our own metropolitan railway, or the new Paris lines to learn that. As to the delay and cost of lifts, these were much less than people thought. On the Central London Railway the cost worked out at 0·1d. for everyone who got into a lift. The idea that rapid transit could be got by a motor car service in the street was wholly fallacious. There were too many crossings, with the inevitable policeman to manage the traffic.

Mr. Fox dealt with the whole subject from a different point of view. He said that it was absolutely necessary to go deep enough to make their tubes or tunnels in the London clay. In considerable districts sand and gravel lay on the clay; when that was the case the lower stratum of the sand was always water-bearing. Any attempt to get in a shallow subway in these districts would entail pumping. The sand would then begin to run, and the result would be the wrecking of house property by settlement. The system had yet to be invented which would take out the water and leave the sand. Under these conditions there was only one system available, namely, to freeze the strata, and no one had ventured to suggest this as within the range of practical engineering. The lesson taught by Glasgow and its shallow tunnels would not readily be forgotten by engineers or contractors. Much had been said in certain newspapers about a crack in St. Paul's Cathedral, which was said to have been caused by the Central London Railway. He went and examined this crack carefully and hunted up its history. The railway had nothing to do with it. The crack was over sixty years old, and was caused by a settlement brought about by the construction of a sewer by the Corporation in the year 1835. The makers of the sewer pumped out sand with the water, and so caused the mischief. He criticised the Elberfeld Railway very severely. It was 100 per cent. heavier than the Liverpool Overhead Railway, most obtrusively ugly, and very unpleasant to travel on, because of the way the carriages swung. As to ventilation, they must have it, and it must be mechanical. To change the air as proposed, once in twenty-four hours, was no use, it must be changed at least twice every hour, in order to keep it up to the standard of colliery and ironstone mining ventilation. As for CO_2, that was not in itself mischievous, but it was an indication that the ventilation was bad, and that other noxious impurities which the chemist and the bacteriologist had not yet learned to detect were present.

Mr. Huddleston said that an overhead railway will carry as much as any other system; it is all a matter of access to the platforms. The cost of a tube was very little affected by the depth at which it was made, but it was found in practice to vary very nearly as the square of the diameter. That of a shallow rectangular underground line varied almost exactly as the width, the height being, of course, fixed. He had found by experiment that the time lost in going to and from trains was about the same on the District Railway and the Central London; the average time in a lift was half-a-minute. It would be a mere waste of money to increase the size of a tunnel from 11ft. 6in. to 12ft., the additional 6in. would be of no use.

Mr. Cottrell replied generally on the whole discussion. The most interesting statement he made referred to ventilation. The cost of ventilating the Mersey Tunnel and working the lifts was 20 per cent. of the entire working expenses. As to ventilation, it was full of puzzles. He cited the case of a Liverpool tunnel, one end of which faces the prevailing winds; a regular hurricane blew through this tunnel, and yet they found about 15 parts in 10,000 of CO_2 in it. No ventilation could improve that tunnel.

SECTION III.

In this section two papers were taken on Thursday. The first was by Monsieur E. Sauvage, and appears below.

"THE USE OF PETROL MOTORS FOR LOCOMOTION."

The motors considered in the following note are internal combustion engines burning liquid fuel, chiefly light products from the fractional distillation of crude petroleum, and, in a few instances, alcohol.

Petrol motors are largely used for locomotion on common roads; their application to tramway and railway working is very limited as yet. On water they are successfully applied to the propulsion of small craft. The road vehicles are generally of moderate weight, such as bicycles, tricycles, motor cars for country travelling and for town use, and light vans for distributing goods; petrol motors are seldom employed on public conveyances for passengers, or on heavy transport wagons.

The power of the engines usually ranges between 1 horse-power and 24 horse-power, leaving out of consideration motors of 100 horse-power or more used for racing. The desirable qualities in the engines are lightness, simplicity, absence of excessive vibration and noise, durability, and economy of fuel. Lightness requires quick-running engines; speeds of 1500 revolutions per minute have been used, but for good working and durability it is advisable not to exceed 800 revolutions per minute. The weight is further reduced by the use of special steel for the working parts and of aluminium for the casings. The good construction of these engines requires very severe tests of the materials and the use of the best machine tools.

For simplicity, automatic admission valves are largely used, but a tendency exists, in recent construction, to revert to mechanical operation for both valves, especially in very quick-running engines, as giving a more precise distribution. A closed casings, forming an oil reservoir, effects the lubrication in a simple and effective manner.

Absence of vibration and regularity of motion are obtained by the use of several cylinders, four cylinders being resorted to even for 12 horse-power engines, but this plan seems to entail unnecessary complication. Balancing is sometimes effected by the use of two pistons in one cylinder, moving in opposite directions, as, for example, in the Brillié motor. Vertical engines are far more frequently adopted than horizontal engines.

For economy of fuel, it is of prime importance to mix the fuel and air in precise proportions, the quantity of air being about 1·6 times what would be strictly necessary for complete chemical combination. Many carburetters have a special aperture that can be regulated at will to admit a supplementary quantity of air, but this regulation is made at a guess. The Krebs carburetter is designed to give the exact proportions of air and fuel at any speed of the motor.

Mention must be made of the Brillié system of distributing oil by means of a revolving cock. A regulating device is, as a rule, necessary in order to keep the motor running at its proper speed; but motors may with advantage be worked at lower speeds in some cases, especially with carburetters that maintain an exact proportion of fuel.

The best mode of ignition seems to be by means of an electric spark, as the moment of firing is well determined, and can be altered when necessary. For generating the sparks a small magneto-electric machine may be used, or an induction coil, with a primary or a secondary battery. The circuit may be interrupted in two places, thus emitting two sparks at the same time, one in the cylinder and the other outside, so that better control of the ignition is secured

Effective water circulation is a necessity, except for very small engines, which may be air-cooled. For cooling the water, the ordinary radiating coil, consisting of a pipe with outside projections, seems more reliable than the bee-hive radiator, which is more subject to leakage. In recent construction a fan is often used to blow air on to the radiator when the carriage is standing. This fan ought not to interfere with the current of air resulting from the speed of the motor car.

A circulating pump is an accessory the good working of which is of the first importance. The best arrangement is to dispose in succession the pump, motor, radiator, and tank. Centrifugal pumps are very simple, but not very regular in their action, especially when the motor is running at reduced speed. They may become quite ineffective in case of partial obstruction of the pipes. Rotary pumps are more complicated, but more effective if in good order.

Excessive cooling is detrimental to the economic working of the motor, but some experiments show that it increases the power; 75 deg. Cent. (167 deg. Fah.) seems to be a suitable temperature for the water leaving the jackets.

The use of heavy petrol oils is not usual in motor cars. Alcohol has been used in some cases, generally mixed with an equal volume of petroleum spirit. The working may be satisfactory if the proportion of fuel is good and the alcohol well vaporised. The carburetter must be slightly heated by part of the water from the jackets or by part of the exhaust gases. The proper regulation of the proportion of fuel is even more difficult than with ordinary petroleum spirit. Starting is more difficult. When alcohol mixed with an equal volume of petroleum spirit is substituted for pure spirit, the consumption in weight for a given power does not increase largely. If pure alcohol is compared with alcohol and spirit mixed, the relative consumptions are, on an average, as 1 and 0·7, by weight.

With regard to transmission of power from the motor to the driving wheels, one special feature is the necessity for change-speed gearing. The Louet system is worth mentioning, in which a sliding frame substitutes couples of toothed wheels between two fixed wheels, the motion of the frame being at right angles to the axis of the wheels. A few applications of expanding and contracting pulleys, such as that of Fouillaron, may be seen. Transmission to the wheels is usually by means of two chains; in some cases, even in large motor cars, an articulated shaft is substituted for the chains, and seems to offer some advantages.

Long and low frames, supported on wheels of small diameter placed wide apart, are being more and more generally used. Mixed frames, of wood and plate iron, combine lightness, elasticity and sufficient strength. Wheels are built of wood, with pneumatic tires.

The weight of ordinary motor cars does not exceed one ton. No type of much heavier car, such as an omnibus or stage coach for passengers, has met with really practical success. One difficulty is to provide pneumatic tires supporting these heavy carriages, and these tires are hardly to be dispensed with, as, at the speed required, without pneumatic tires excessive shaking results, which is detrimental to the frame and the machinery, and inconvenient to the passengers.

Heavy transport wagons are also very rare. As a slow speed is sufficient in that case, elastic tires are not a necessity. Economy requires a high carrying capacity, 5 tons at least. The weight of such a chariot is about 4 tons, making a gross weight of 9 tons. Such a weight is already excessive, and could not be increased without serious damage to the roads.

For tramways, the use of oil motors is very limited, if any are in service.

The same may be said of railways. Although it seems that an automotor car, with a seating capacity of thirty to eighty passengers, capable of hauling, when necessary, an ordinary carriage, would be useful on some branch lines, no such car, worked either by petrol or steam motor, has come into really practical use. Electricity has found more favour for this special railway working.

Mention must be made of small petrol locomotives used in Germany and Austria for haulage in coal mines. In case of firedamp, the petrol reservoir is well closed, a small pump being used for the injection into the cylinder, and the exhaust is discharged into a large cooling pot, the gases escaping through wire nettings.

For small launches, petrol motors are very convenient; they do not require change of speed, but only a reversing device. Sometimes propellers having reversible blades are used. No application of petrol motors, on a large scale at least, has been made to big boats; for this purpose motors worked with heavy oils would be required.

Good police regulations for motor cars are of importance, and not easy to frame, especially with regard to speed. Ought exact limits of speed to be prescribed, and would it not be better to forbid "reckless and furious driving"? But the limits of what is reasonable are not so apparent with motor cars as with horses. For heavy transport, limits of weight, and corresponding minimum widths of tires, must be fixed.

In conclusion, petrol motors are extensively used as a means of locomotion for purposes of personal convenience or pleasure; but their employment as an economical mode of transport is as yet rather exceptional. Delivery of goods in towns by means of motor cars may in some cases be adopted for the sake of economy, but in many instances the advertising side of the question comes into play. For this reason, data regarding transport by means of petrol motors, when the question of price is the chief one considered, is of great interest. Amongst the desirable figures, the following ought to be specially noted in particular instances, as far as possible: Weight of empty vehicle, weight carried, usual speed, mileage done daily and yearly, nature and profile of roads, cost of vehicle, consumption of petrol spirit, cost of repairs; total cost of operation.

The discussion on this paper lacked spontaneity, and was only connected with the paper by the slightest thread. It was opened by Mr. Darley, who introduced the suggestion that petrol might be used for the propulsion of motor railway coaches for dealing with back country lines in the Colonies, and little used lines in general. He spoke also of the electro-petrol car, like that being tried on the North-Eastern Railway. The whole discussion centred round these two points, various speakers dwelling on the advantages of motor railway coaches, whilst others, notably Mr. Aspinall, spoke as strongly against their use. Mr. Aspinall pointed out a few of the difficulties that attended the employment of combined stock. For one thing, if the engine broke down, or needed overhauling, the whole rolling stock was put out of use; for another, there was always the problem where to keep the motor coach. Was the clean carriage to be put into the dirty engine-shed, or was the dirty engine to be put into the clean carriage shop? But the great objection was that the motor coach soon became inadequate for the requirements of the line. It was useful in the early days, but the traffic soon became too heavy to be dealt with by it. He instanced the case of a motor coach made by Mr. Macdonald at Inchicore Works in 1876. It is to be regretted that neither Mr. Drummond nor Mr. Worsdell was present to give his views on the question.

Professor Capper touched upon the value of road motor cars for carrying passengers to railway centres, whilst Mr. Warren advocated the development of engines using ordinary kerosene, because the difficulties of procuring petrol were increasing, and because it could not be obtained at all in hot climates.

Part of the debate turned, as we have said, on petrol-electro locomotives, and in this connection the Heilmann locomotive came in for some discussion, Mr. Aspinall, Captain Sankey, and Mr. Robinson taking part in it. It appeared that the remarkable economy of fuel, said to have amounted to 45 per cent., was due to the fact that the engine ran quite free down hill, there being no mechanical connection between it and the wheels.

M. Sauvage, who replied in excellent English, supported Mr. Aspinall's views on the use of motor coaches, and Professor Capper's desire to see the development of outlying district by motor cars.

The next and last paper in this section was read by Professor J. D. Cormack, and both at the reading and during the discussion many members from other sections were present. The paper is as follows; it is, as Dr. Kennedy remarked, dispassionate and clear, lending itself well to discussion:—

"APPRENTICESHIP IN ENGINEERING TRAINING."

The subject of this discussion is wide and complex, and as the scope of the title may be misunderstood, it is well at the outset to make it clear, although it may seem, at the same time, to be extended and restricted.

"Engineering" is to be understood as including all branches—to be, in fact, civil engineering in the wide meaning of the term.

The use of the word "apprenticeship" may, to some, indicate that only one or two branches of engineering are to be considered, and to others it may seem that it is the training of the workman which is to be the subject of the discussion.

But an apprentice is simply a "learner;" whatever be the branch of engineering, or whatever be the aim or the ultimate end

of a young engineer—whether he is to be a workman, or whether he is to be an employer—during his apprenticeship he is a learner. The title, therefore, includes "pupil," although this term is sometimes used to distinguish a learner in certain branches, while in other branches it is used to distinguish the "paying" apprentice who aims at being an employer or designer, from the "paid" apprentice who becomes a workman.

These extended definitions embrace too wide a field, and it is necessary to limit it by confining ourselves to the training of youths who are destined to be employers, manufacturers, or consulting engineers, designers, heads of departments, technical managers, and men in responsible positions. Whether or not such an apprentice should pay or be paid is a matter for the decision of individual engineers, or engineers in different branches, and this question may therefore be left out of the discussion.

Until the beginning of last century, entrance into the trades and the professions could only be obtained by means of an apprenticeship extending over seven years, during which the apprentice was bound to serve a master, who, on his part, undertook to keep the apprentice and to teach him his work. The system, as it then was, led to many abuses, and the Act of 1814 was designed to counteract these. It opened wide the doors to all except a few professions, and no restriction was placed either on the manner in which a youth learned his future occupation, or the duration of his training. At that time engineering, except in a few branches, was just emerging from its position among the crafts. The removal of the restrictions to entrance may have been harmful in some ways, but at all events it allowed free entrance to many men who, although trained for other pursuits, became pioneers in different branches of engineering.

Although the restrictions were removed, there still remained the idea that the proper way to become an engineer was to spend a period of five years or seven years in the workshop or office. Probably, then, in the existing state of what we are now proud to call the profession, this was desirable, but now, after a century which has seen vast developments in engineering practice, and during which, with ever increasing rapidity, scientific discovery is turned immediately to practical utility, it seems reasonable that some more generally recognised system of apprenticeship should be devised or recommended to suit the new conditions.

The inadequacy of the old system of apprenticeship has been realised for some time; so long ago as 1866, Sir John Fowler laid stress on the importance of combining the study of science and engineering theory with the ordinary apprenticeship. Since then it has become more generally recognised that the proper training for an engineer involves training both in theory and practice, and this has for the past seven years been emphasised by the Institution in demanding a knowledge of theory from candidates for Associate Membership.

When the technical education fever was at its height, opinion, to some extent, went to the other extreme, and it was thought by many that at last we had arrived at the solution of the problem. The numerous universities and technical colleges were expected to be able to turn out young engineers equipped not only with the necessary technical knowledge, but with experience gained in the college workshops

In the United States and on the Continent this system of training has been, to a large extent adopted, but there are indications of an increasing tendency to diminish the workshop practice in the colleges, and to substitute a training in workshops under commercial conditions.

E-pecially in the case of the United States does one see excuse for such a system, for the extraordinary rapidity of the increase of engineering business there has created a corresponding demand for young men, possessed of scientific knowledge and some technical training, and capable of filling responsible positions.

In this country, however, starting with a pre-eminent position in engineering, we have advanced with the times, perhaps at a less rapid rate than elsewhere, but still with sufficient prosperity. Interest in the training of young engineers has not been so generally aroused. Biassed as some were by the old traditions, infected as were others by the technical education fever, the advice given to our young engineers has been very varied, with the result that at present training is in some quarters found to be in a rather chaotic condition.

The ever-increasing keenness of international competition urges us to a solution of the problem, and this alone should be sufficient; but the call seems still more emphatic when we remember that the function of the engineer is "to direct the sources of power in Nature to the use and convenience of man," and realise his cosmopolitan duties. The beneficial directing of the forces of Nature implies a knowledge of the laws governing their behaviour. The definition of the title "civil engineer demands from him both theoretical knowledge and practical experience, and in this discussion I think we may take as agreed that both are essential in the training of the engineer.

The Institution has for many years devoted most careful attention to the conditions of training which should be fulfilled by those coming under its purview. The "regular training" prescribed by its by-laws is defined by the Council's rules to involve a minimum period of three years' pupilage or training as an assistant, where the standard of education is simply that required for admission as a student; and such minimum period of practical training may be reduced to two years where a recognised college course of study is taken. In each case the practical training must comprise both experience in the office and in or upon the works.

The Institution clearly contemplates a scientific and a practical training for all, and taking this as a matter of common agreement, the questions to be discussed are:—

(1) How should the knowledge and experience in each be acquired?

(2) Is there any arrangement suitable for all branches of engineering, and if not, what modifications are required for the different branches?

(3) Over what period of time should the complete training extend; and what is the best arrangement and division of the time?

Let us look for a moment at the raw material and the finished product, leaving out of account the genius who may achieve eminence in engineering without special training. The raw material is a youth of seventeen or eighteen, fresh from school, educated perhaps to a standard below that which might be desired or expected, and supposed to be endowed with common sense, natural aptitude for the profession and sufficient physical strength; and the finished product is a blend of scientific and technical knowledge, practical experience, and business method. Our colleges should supply the first two requirements, but I venture to submit that the last two can only properly be acquired in the workshops and offices, and that no training can be considered efficient that does not include a considerable period of practical apprenticeship. Colleges may supply knowledge relating to the properties of materials, the theory and structure of machines, instruction in testing and in the method of attacking new problems; but it is only under actual commercial conditions that there can be acquired the proper type of practical experience, adequate knowledge of the design and construction of machines, experience of and sympathy with the workman. It is in the factory or office that there can be gained, by observation and imitation, some knowledge of routine, estimating, organisation and management business methods and administration, the production of the maximum amount of work with the minimum friction and at the minimum cost. Imitation of good example counts for much in engineering as in other professions, and to this, no doubt, can be largely traced the continuance of the success of our national engineering, despite our comparative slowness in advancing with the times. It is in this respect that continental and American systems of training will be found deficient. There the young engineer is launched into his future occupation after a college training of four or five years with workshop experience gained, especially in America, only in the college, and with sometimes a total commercial experience of a year or less.

It is seldom that a youth, when he enters the profession, knows what special line he will eventually follow. The organisation of this Engineering Conference indicates at least seven important branches of the profession. He may be trained as a mechanical engineer and eventually end as a railway engineer, an electrical engineer, or a naval architect. There is no broad line of distinction, the branches being so closely related. The mechanical engineer must not build machines without considering the purposes for which they are intended. The dynamo manufacturer cannot look at a combined set solely from the commutator or collector end; the railway engineer cannot confine his knowledge to the finished girder or the finished locomotive, and the naval architect is not concerned simply with the lines or hull of a ship.

Underlying all branches there is to some extent the same practical foundation. All demand knowledge of the properties and uses of materials of construction, and of the methods and processes by which they are converted into structures and machines. In many of the branches it is generally realised that a man must go "through the shops," and after all, the processes in one "shop" do not differ greatly from those in another. Work shop experience is not, however, generally included in the training of all engineers, but surely it is desirable for all, and especially and increasingly so when steel has displaced to a large extent masonry and timber, when all types of motors bulk largely in their work, and when machines of all kinds are utilised to construct to their designs.

If it is considered desirable that the training of all engineers should include experience in suitable workshops and factories, specialisation being confined more or less to the drawing-office, the question under discussion is limited to the consideration of the time required, and the best division of that time between the college and the workshop. The duration of training depends to some extent upon the arrangement of the course; but, probably, it may be safely said that to produce the ideal young engineer the training should extend over five or six years, which might be about equally divided between the college and the workshop.

Is there any one system that is the most desirable? I leave it to discussion chiefly by engineers in practice, as I feel certain that the colleges are anxious to have a solution of this problem, and to adapt their courses to any scheme or schemes that may be thought desirable.

In this country at the present time the systems in operation might be classed as—(*a*) 1 and 2, "separate" systems. (*b*) 3 and 4, "combined" systems. (*c*) 5 and 6, "compromises."

(1) *Workshop only.*—This is a survival of the old traditions. It demands physical exertion during the day and mental strain at night if theory is to be acquired. Many eminent men in the past have undergone the strain and emerged successfully; but in the future the ever-increasing demand upon the engineer will render it unpractical, and almost impossible. Many clever youths enter the shops on this system with limited opportunities but with great ability, and provision should be made for them in any scheme of training.

(2) *College only.*—This has already been alluded to. Under exceptional circumstances, such as obtain in the United States, it may be expedient, but it is undesirable.

(3) *Works before college.*—A youth entering college after, say, three years in the factory and office is in many respects a good type of student. He has gone through the shops at the receptive and imitative age; he has ascertained whether engineering is still to his liking, and comes to college with a knowledge of processes, materials, and machinery. He has some idea of what he wants to know and what branch he wishes to enter; but has often wrong theories which are difficult to uproot. Teachers prefer this type, provided he has continued his studies during his apprenticeship; but this is not always or even generally the case. The youth may have forgotten much of his school training, and, what is worse, he may have forgotten how to study. If he has studied it is under trying conditions, when he is physically tired, and he may wish to confine his studies to the more interesting technical subjects, the science underlying them being more or less neglected, and in consequence his progress is less rapid. He comes to college probably disinclined to begin again and gain the scientific knowledge which ought to precede all its applications.

(4) *College before works.*—A youth fresh from school and sufficiently educated is likely to make good progress in his scientific studies. In the technical work he is handicapped by his want of knowledge of manufacturing processes and the operation of machines, and is unable to associate his theoretical studies with practical examples of which he has had experience. Laboratories help to some extent to reduce the handicap. If this was to be the standard training there would be a greater plea for college workshops, which would supply some little practical experience, but which could not supplant, even partially, the workshop training under commercial conditions. Some may urge that this system produces a man disinclined to undergo what he calls the "drudgery" of the workshops, but others will be as ready to admit that the proper type of youth acquires his practical experience at a much more rapid rate after he has undergone a college training, and has no such disinclination. This system may be preferred by employers as distinguished from system (2), which may be preferred by teachers.

Other systems are in vogue, either by accident or design, whose object is to avoid the disadvantages connected with "separate" and "combined" systems, or to minimise the required period of training.

(5) *Intermittent systems.*—These include the works-college-works and college-works-college systems. Many arguments can be advanced by the advocates of each. The first arrangement has to a lesser extent the disadvantages attached to system (3), and the latter system those of system (4). Both waste time, in so far as the usual college terms extend over only nine months of the year, and the remaining three months may be wasted, as few engineers care to take youths for three months in the year. But probably, on the whole, this system is preferable to (3) or (4). In the college-works college system the youth fresh from school has an opportunity of acquiring a foundation of science on which to rest his works experience; but if study is not continued his knowledge may evaporate in the works, and at the end of his training he is out of touch with his employers.

(6) *Sandwich system.*—This system goes one step further. During a period of, say, five years training, for four years, six months of each year are spent in the factory or office and six months in the workshops, and the additional year is spent in the workshops or office. It lessens the discontinuity between the two parts of the training and effects a saving of time, inasmuch as the college long vacations are utilised. An objection which may be put forward is that the youth is always "on the move." He has no time to settle down to either the workshop or college work, and he may have difficulty and extra expense in arranging for lodgings. It must not be forgotten, however, that each part of his work forms a recreation for the other, and the student is likely to return to each with considerable keenness.

(7) *Concurrent systems.*—These either give time for study in classes in connection with workshops, or offer workshop training in connection with college. Both systems have already been alluded to.

The objections to (1) and (2) may be applied here. Time taken off the workshops for study gives less time for the practical experience, and this is not acquired under strictly commercial conditions. Except in the very largest works it is impossible to provide the requisite standard of teachers, and if it is necessary that the youths should breathe the atmosphere of the shops, probably it is perhaps equally necessary for him to breathe the atmosphere of the college.

The list may not comprise all the systems in vogue, and the arguments for and against them are merely indicated, but it serves to emphasise the diversity of the ways in which a youth may enter engineering. Is it not possible, at least to some extent, to standardise the training?

On account of the large number of members who wished to speak, the President limited each one to seven minutes.

Mr. Dugald Drummond explained broadly the system of training apprentices at the Nine Elms works. Boys are taken at the age of fifteen or sixteen, and are bound for three years. Every boy after he has passed a certain standard attends a junior class for one hour on three mornings in the week or a senior class for one hour on two mornings in the week. At the end of each session of six months there is an examination, and those who are unable to pass drop out of the special training, whilst those who pass are encouraged and assisted to go to a technical college, taking college and works alternately. At the works they are allowed to select what department they like, either the drawing-office, laboratory, &c. He thought this combined training had many advantages, but he laid special stress on the necessity of thorough shop training. No one was quicker to find out ignorance in those put in positions of responsibility over them than the workmen, and it was therefore essential that a man who was to hold such a position should be thoroughly trained in the various crafts. He concluded by hoping that this would be the last discussion before the whole question came before a committee especially appointed to consider it.

The following notice to apprentices has been posted up in the Nine Elms works. It gives in greater detail the scheme of education outlined by Mr. Drummond:—

I am anxious that the apprentices in the London and South-Western Railway Works at Nine Elms should have every possible opportunity afforded them of having a scientific education, arranged to go hand in hand with their practical every-day work, and so enable them to prepare, at the end of three years, to take up the higher scientific training to be obtained at the technical colleges during the last two year of their apprenticeship. The course will commence in October and end in February.

This has been arranged to enable you to have proper time for study in the evenings, and to compare the scientific teaching you receive at the classes with the practical work going on in the workshops, so as to cultivate the habit of thinking independently for yourselves.

I have arranged for a competent teacher to give one hour, from 8 a.m. to 9 a.m., on three mornings of the week for juniors, and one hour two mornings of the week for seniors, which will form part of the day's work.

You will be expected to pass a preliminary examination in proportion, fractions, cubic and square root and mensuration, before being allowed to join the classes.

At the end of three months in each term an examination will take place to enable me to ascertain what progress has been made; the final examination to take place at the end of each term.

Those who pass the final examination will enter the higher class for the second year, and so on to the third.

Those who fail to pass the first examination, but receive from their teacher a recommendation, will have the privilege of continuing in the same class another year to give them the opportunity of passing into the higher classes.

Those who do not receive a certificate from the teacher, or who fail, at the second opportunity of passing, will have to retire from the classes.

I will arrange for those who fail not to work overtime during the winter months, so as to enable them to attend evening classes if they so desire.

The apprentices who pass all their examinations satisfactorily will be allowed to attend the engineering colleges during the winter months to secure a higher education, and the time so occupied will be counted as part of their apprenticeship, and those who successfully pass the college examinations will have the privilege of entering the drawing-office or the chemical laboratory during the summer months.

This privilege will continue for the last two years of their apprenticeship.

Those whose conduct is satisfactory and who have shown ability both in workshops and in technical work shall have the first call for promotion. I therefore hope that every apprentice will do his utmost to improve his knowledge and so become eligible for promotion.

Any lad whose parents have not had the means to keep him sufficiently long at school to give him an education such as would qualify him to pass the preliminary examination will call upon me, and I shall endeavour to make such arrangements as will enable him to acquire the necessary knowledge to do so.

The three subjects for the session will be "Applied Mechanics," "Heat," and "Electricity." Only one subject will be dealt with until the class is thoroughly capable of understanding it before the next is entered upon.

The directors have kindly agreed to pay the teacher's fees for the first three years.

D. DRUMMOND.

Mr. Stromeyer dwelt upon the importance of the apprentices making acquaintance with the men and so learning the nature of the material with which they would have to work when they came to positions of authority, for this reason he thought it desirable that boys should go into works as early as possible.

Mr. Allen expressed practically the same views as he did at the Institution of Mechanical Engineers in the discussion on Professor Dalby's paper. He is opposed to the six month sandwich system, because he believes in continuity of training, and he thinks that the interest of a lad will be destroyed in both his college and his shop work if he has to give it up at a certain specified time. Either the college course or the works course should be taken first, which he would leave to the inclination of the individual, but he was inclined to favour works first. Three years' shop training he considered ample, and he could not see why the engineer should be expected to be skilled in chipping, filing, and so on, any more than the architect was expected to be a good carpenter or bricklayer. The observation should be particularly trained, and much attention should be given to testing and the study of results.

Professor Jamieson said that after an experience of the sandwich system extending over twenty years he found himself in agreement with Mr. Drummond; boys should go to works and continue for at least three successive years, but he would not pamper them with morning classes, and he strongly advocated attendance at evening schools or learning by correspondence. At the end of the three years he would select the best students by examination, and give to them training on the sandwich system. Six years in all were necessary to make a fully-fledged engineer. He did not know of a single person

DOVER HARBOUR

(For description see page 648)

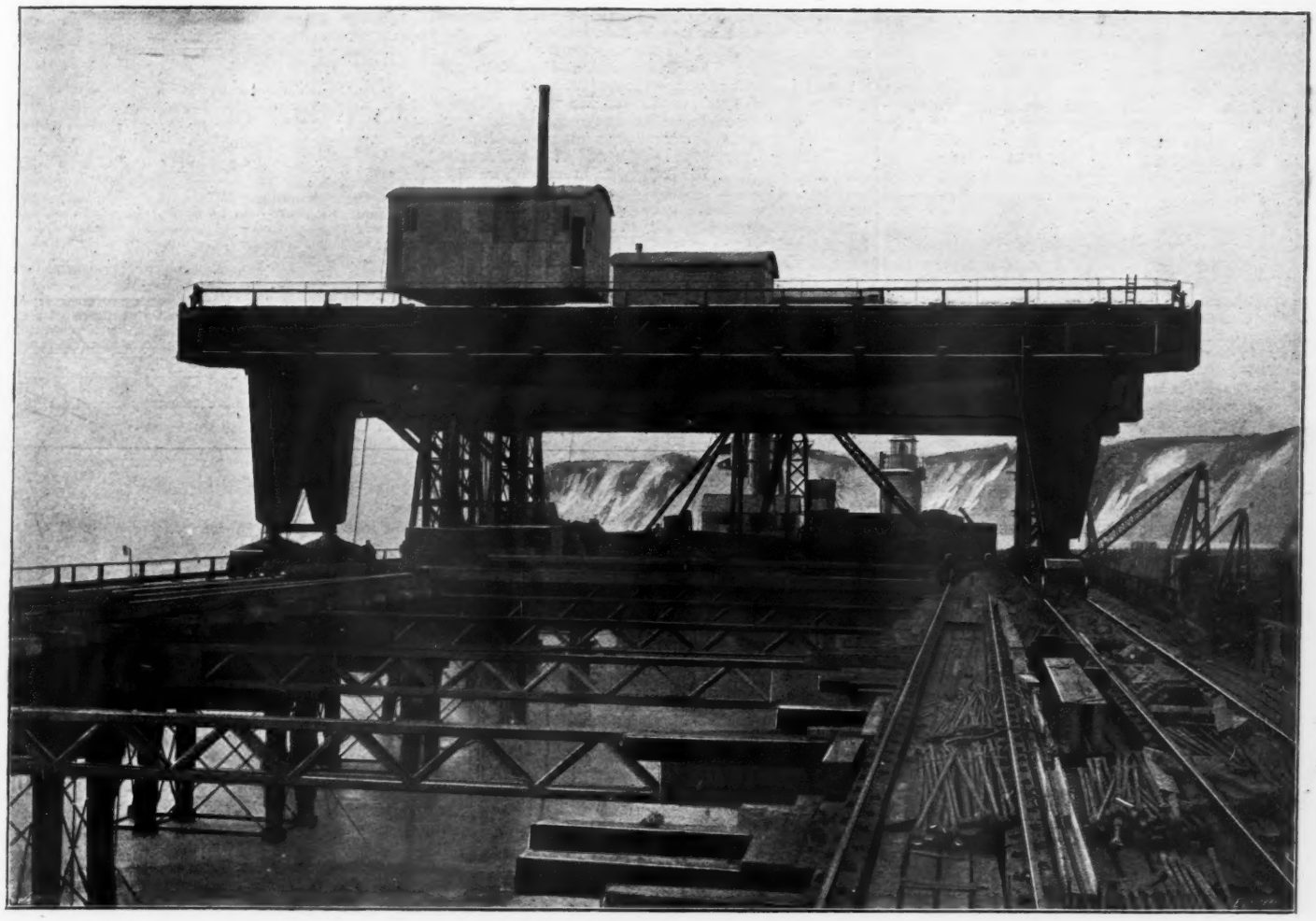


Fig. 1—TEMPORARY STAGING FOR THE ADMIRALTY PIER EXTENSION

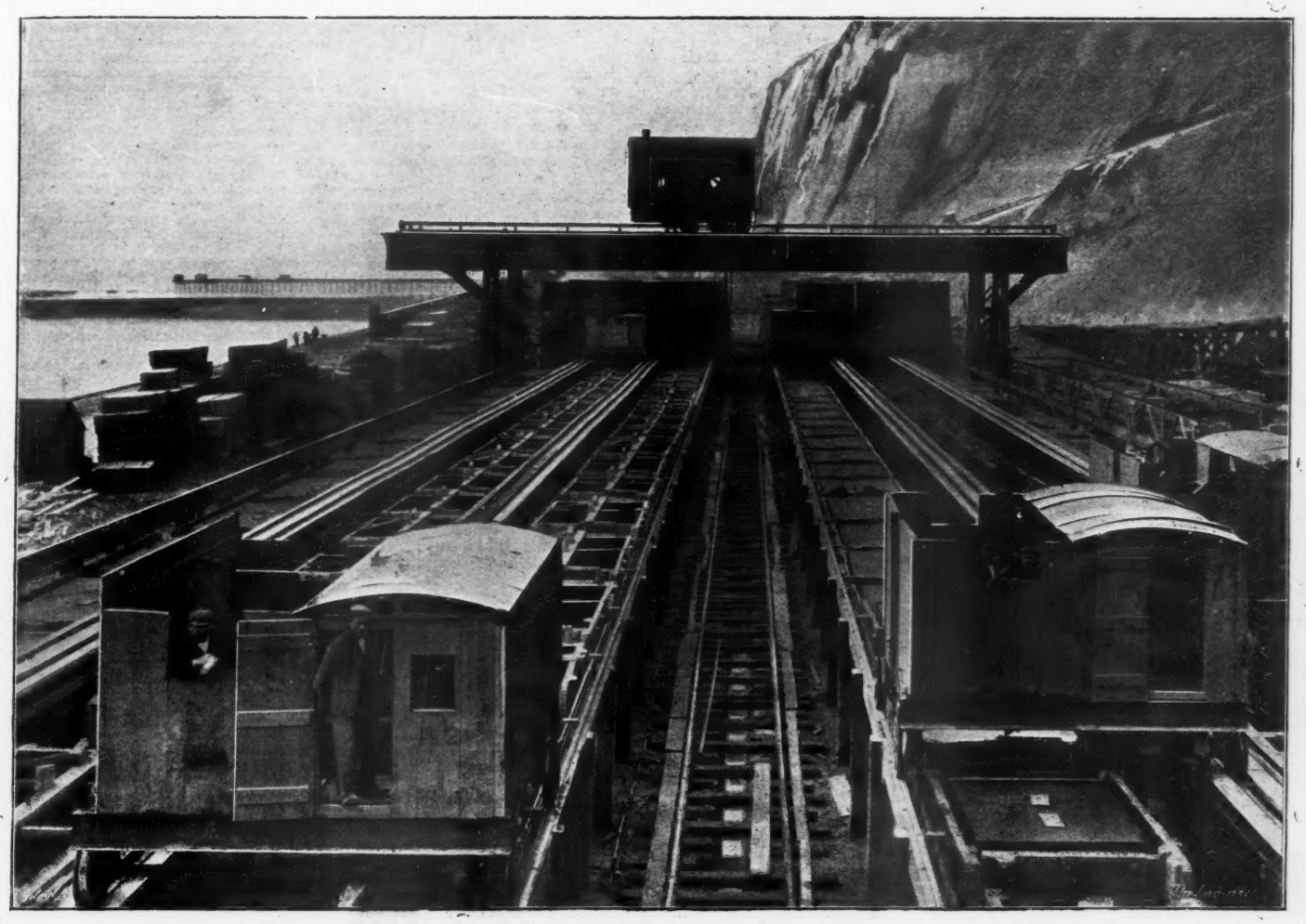


Fig. 2—BLOCK YARD AND CONCRETE MIXERS ON EAST RECLAMATION

in Scotland who had a university degree in engineering holding a position of responsibility. The sandwich system as practised in Scotland had not resulted in the production of men fitted to become head managers.

Mr. Henry Davey spoke of the origin of the apprenticeship system, and of the exaggerated notions about the value of college workshops. The latter could never replace actual workshop training, and their right use was to train youths to accurate observation, and to make him acquainted with the materials used in engineering, and methods of conducting experiments. He thought some kind of sandwich system was necessary, but he was not convinced that the six months plan was the right one.

Mr. Thos. Parker was in favour of a yearly sandwich, giving first, after a good general education, one year in the works. But he objected to the kind of education given in the colleges. Too much pure mathematics and theory are taught. Young men leave college primed with formulæ. Now, engineering as a business, is all a matter of approximation, and they find that they have to get these exact formulæ knocked out of their heads. With very simple calculations, a quite sufficiently accurate working approximation can be reached, and the colleges ought to teach the young men how to make such calculations. Greater simplicity in training was required.

Mr. Yarrow spoke strongly in favour of giving equal chances to the poor and the rich lads. He would have them all start work at six in the morning, and he felt confident that after a good day's work a youth is not fit for much study in the evening. He did not approve of either classes attached to works, which could not be so efficient as properly equipped colleges, nor of workshops attached to colleges. The use of machines should be learnt under commercial conditions, because then not only is the use of the tools learnt, but also the knowledge of the administration of works. Moreover, by coming into contact with the workmen, the apprentices acquire the most essential requirement for success and for the control of bodies of men, namely, tact. He then went on to speak of the six months' sandwich system with which his name has been associated, and urged the employers to come to some decision as to what plan they considered best, for he knew that the educational authorities were only too willing to meet their views.

Mr. Parsons described the difficulties and disappointments he met with 20 years ago when organising the Yorkshire College at Leeds. He and his colleagues were always being asked to show what good could be done by technical education, but when they tried to get the engineers of the district to join with them in providing a really good training they met with no support or sympathy. Now-a-days, however, manufacturers were beginning to appreciate technical education. Speaking as a member of the Council of King's College, he said that they were anxious to adopt the sandwich system if it really was the best plan, but it had several disadvantages. For one thing it would add another year to the course, and it would increase the expenses of education. He estimated that King's College would require about £1000 more per year than at present. These were very important points, when it was remembered that the problem they had to face was the quickest and cheapest means of giving a satisfactory training to students who were without private means. Moreover, he agreed with Mr. Allen that the discontinuity of thought necessitated was a bad feature.

Colonel Crompton was in favour of the "works-college-works" system, and was dead against the short sandwich system. The object of education should be to make a man capable of taking part in business immediately his education was over. He must know how to utilise his materials to the best advantage, how to design, how to get work through the shops, and last, but not least, he must be in touch with the men and understand their management. If a youth goes to college first he is unable to appreciate the reason and object of the training afforded, but if he goes first to works, and then to college at about nineteen, he goes with a condition of mind best fitted to profit by what the college has to give him. Two sessions at college should be enough, and the student should then go back to the works to assist the management in various departments. One of the disadvantages of the short sandwich system was that the time in the works would frequently be insufficient to allow the student to see the result of work done in the shops.

Mr. Hall Blythe spoke of the education of the pure civil engineer. He thought colleges did not pay enough attention to the bread-and-butter side of business, and he dwelt on the absolute necessity of practical training.

Mr. Bertram Hopkinson spoke as a representative of the students. He deprecated the tendency to standardise education. He appeared to advocate the sandwich system, because it had the advantage that it kept the students constantly under the eye of the professor, and because it introduced a certain amount of variety.

Mr. Jenkins spoke of the disadvantages of the sandwich system if applied to mining and metallurgical students.

Mr. Mark Robinson thought the sandwich system was on the right lines, but the slices should be cut thicker. Willans and Robinson would be willing to take four pupils under this system.

At this point an adjournment was made for luncheon; and the numbers present on re-assembling were much reduced.

Professor Ayrton explained that he had devised the system now advocated by Mr. Yarrow thirty years ago in Japan, and that it worked excellently there, but it had to be said that the conditions were not quite the same, since the professors had the control of the Government workshops. He favoured also a thicker sandwich, say, one year slices. He strongly urged the employers to say what they wanted, for the professors would be quite willing to fall in with their views. What was needed was to train students so that they might be able to improve the methods used in industries. They must be taught on business lines. Students must be conversant with prices, &c., and must learn to observe how modification in designs and methods altered the price of production. He strongly defended the college workshops. They were often looked upon as an adjunct to the college, but he preferred to consider them from the opposite point of view, the lecture-rooms and laboratories were to be regarded as adjuncts to the workshops.

Professor Burstall explained that the sandwich system had been rejected at Birmingham because they could not find places for half the 150 students they had on their books each year. They had therefore decided to have college workshops and to run them just like a real works. Their policy was to provide a man who, on leaving college, would be useful to the employer, and they could now place out twice the number of men with sufficient salaries to maintain them at the end of the four years' course. Pressed by Mr. Dunell on this point, he left it to be understood, however, that it was only for the best men that such positions were secured.

Professor Capper supported Professor Ayrton in asking the manufacturers to say what they wanted. The professors and colleges would gladly meet them.

Mr. Ferguson thought the old apprenticeship question had very much to recommend it; Mr. Moncrief advocated works and evening classes; and Captain Sankey favoured the one year sandwich.

Sir William White said that, though there was great difference of opinion on various matters, on one point they were all agreed, and that was that a practical and scientific training was necessary. The question that had to be considered was how to deal most usefully with the average man, and on this point the professors looked to the manufacturers for guidance. An agreement was wanted as to the best line to adopt, and he thought that a committee should be appointed to consider the various views expressed. The Institution of Civil Engineers would naturally be the right body to take the initiative in appointing such a committee. He subsequently explained, at the request of the chairman, the system of training officers for shipbuilding and engineering for the Royal Navy, which had been in force for the last fifty years. It embraced two stages: first, service in a college attached to a dockyard for three years; then after a weeding-out process, the successful students went to the Royal Naval College, Greenwich, where the sandwich system is in force, and is a complete success. He quite appreciated the difference between a public service and a private business.

Professor Kennedy, in concluding the debate, said that they had found at University College that the boys who came to them at seventeen years of age not only knew little, but that they did not know how to learn. They hated the elementary classes, and the professors always found the first year the most difficult one to deal with. He thought that if a youth had a year in the shops or in an office before he went to college he would be a better learner. They found the men of twenty-one to twenty-three who had had shop experience excellent to get on with and very keen to learn. He protested strongly against evening classes. They were thoroughly bad for a man, and they were particularly bad for the good fellow who was anxious to get on, for he devoted himself entirely to engineering, and a man who thought about nothing but engineering never made a good engineer. He then invited Professor Cormack to reply, which Professor Cormack did very effectively by suggesting that the different speakers should settle their difference between themselves.

SECTION V.

The Thursday meetings of Section V.—Shipbuilding—were held in the Committee Room of the Guildhall in Westminster. Two papers were brought forward. The first of these was by Mr. John List, and was entitled,

"SCREW SHAFTS."

In recent years the changing conditions of trade (with the United States particularly) have led to cargo steamers being sent long voyages in ballast. In the case of single-screw ships in this condition, the propellers are usually only partially immersed, with the result that the consequent severe racing has led in many cases to broken shafts. So great has been the loss from this cause that the Registry Societies have found it necessary to modify their rules in the direction of increasing the size of the shafting.

The question of the life of steamship shafting is one of considerable importance, and it is no doubt desirable that shafts and other important working parts should be renewed, as in the case of locomotive crank shafts, after running a given mileage. Competition in ocean carrying is, however, severe, the conditions of trade are constantly changing, and ships become obsolete or unprofitable for the trade they were built for, and pass into other hands, so that renewals are not as a rule carried out unless defects incur rejection on survey by the Board of Trade or the Registry Societies. The practice which is now becoming general of building cargo steamers with one or more hold ballast-tanks in addition to their double-bottomed ballast capacity, will, by giving greater immersion to the propellers in the light condition, tend to reduce the risk of broken propeller shafts.

Shafts of moderate size are in some cases forged from selected scrap iron, but the amount of really good scrap in the market is small, and shafting for high-power ships is now generally forged from ingot steel. In first-class work about 40 per cent. of the top end of the ingot and about 5 per cent. of the total weight of the ingot from the bottom should be rejected in the forging. It is also, in some cases, specified that the sectional area of the finished forging is not to exceed one-sixth of the original sectional area of the ingot. It may safely be affirmed, however, that for the ordinary run of steel shafting for merchant steamers considerably smaller ingots, in proportion to the finished forgings, are used.

While for high-power cruisers propeller shafts of, say 24in. diameter are fitted, having the internal diameter about 75 per cent. of the external, it is not usual in full-power passenger ships to find such extreme proportions adopted. In the case of the Atlantic passenger ship Deutschland, the particulars published give the external diameter of the propeller shafts as 25·2in. with an internal diameter of 10in. The conditions are, however, different. In the case of the warships an excessive maximum power on the minimum weight is essential, and the question of first cost must be entirely subordinated to the attainment of that result, whilst at the same time the vessel generally steams at low power. Also the fineness of form necessitates very long outboard shafts with bearings far apart. In the case of the passenger ship the maximum sea-going power is continuously exerted and the shafts are carried in stern tubes housed in the bossing and with long bearings spaced close together. For the hard and continuous work of the Atlantic high-speed service the arrangement adopted is that best suited to the requirements, but it is not applicable to a warship where the extreme proportion of beam to length necessitates an entirely different form of model and arrangement of shafting.

Fig. 1—PNEUMATIC DRILLS AT WORK

Nickel steel shafting has been largely adopted not only in full-power ships on the Atlantic, but also in the shafting of many foreign warships. The crank shafts, thrust, and propeller shafts of the Deutschland before referred to are of nickel steel, and in the later and still higher-power ships of that class the same material is used. The ultimate tenacity of some heavy shafting forgings of nickel steel made on the Continent is 38 to 40 tons per square inch, with about 20 per cent. elongation and a ratio of elastic to ultimate stress of about 67 per cent. Rather softer steel made in this country, and showing 3 to 4 per cent. of nickel on analysis, has been extensively used for shafting, so far with satisfactory results. Its ultimate tenacity is 36 to 38 tons per square inch, with about 30 per cent. elongation on 2in. and an elastic limit of 60 per cent. Such steel will bend cold. For warship machinery forgings, carbon steel of high tensile strength has been used, having an ultimate tenacity of about 35 tons per square inch, with about 32 per cent. elongation on 2in. and an elastic limit of about 65 per cent.

The paper was illustrated by several diagrams on the wall showing defective shafting, forms of steam tubes, &c.

The second paper was by Mr. A. F. Yarrow, and was entitled,

"DRILLED *v.* PUNCHED RIVET HOLES IN THE HULLS OF SHIPS."

In the early part of last year the British Admiralty contracted for a number of destroyers, and stipulated that the rivet holes in the hulls were to be drilled instead of punched, which, up to that time, had been the usual practice. As these vessels are fast approaching completion, it was thought that a few observations on this change in the method of working might be of interest to the meeting, and I have therefore much pleasure in laying before you the results of our experience as far as it has gone.

There can be no question that anything that can be done to improve the quality of the work in lightly constructed vessels of the torpedo-boat class is most desirable, because, reduction of weight being of primary importance in securing high speed, it very often follows that the stresses at the joints are very high. The same may be said of some of the large Atlantic liners.

When the Admiralty first stipulated that all the holes in the destroyers were to be drilled, contractors did not look upon this condition with favour, for it was thought that it involved a great increase of cost and additional time for construction out of proportion to the better quality of work produced.

The method we adopt is to drill the inside strakes of the shell-plating, &c., by electrically-driven radial drills placed near the boats in the yard. The plates are then sheared and put in position on the ship's side or bottom. The outer strakes of plates are then put up, and are drilled in their place by light portable pneumatic drills, the inner plates acting as jigs for the holes in the outer strakes. This operation is clearly shown by Figs. 1 and 2.

The electrical drills were made by the Oerlikon Company, of Zurich. Fig. 3 shows a couple of them mounted on a central post. They are each driven by an independent 1 horse-power motor, which is mounted at the centre, on which the outer arm swings. The speed of the drills is variable between 250 and 500 revolutions

per minute. They are intended to drill holes up to ⅝in. in diameter in steel plates having a tensile strength of about 40 tons per square inch. With these machines we at first used the ordinary Morse twist drills, but eventually we made our own drills from "Speedicut" steel, and found that these were better suited to our purpose than any we had previously tried.

By adopting the system above described the holes are all dead true, and equal in every respect to the best boiler work. They are consequently ready for being riveted up without even a rimer or drift being used, nor any inaccuracy due to not getting the holes exactly in their correct positions. I think it is impossible to have any more accurate system of workmanship, and, what is perhaps more important than any other consideration, it places it out of the power of the workman to do bad work.

I firmly believe that if this mode of construction were applied to our big liners their life would be prolonged; they would not

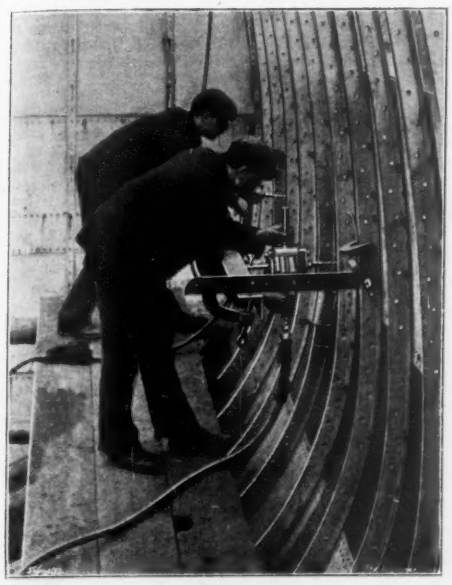


Fig. 2—PNEUMATIC DRILLING

so often need to go into dry dock to have loosened rivets cut out and replaced, seams recaulked, &c. Such repairs frequently would be uncalled for if the work were put together in the first instance in the best possible manner, now rendered practicable by modern tools and modern methods, and the bill for repairs from time to time would be considerably reduced.

It may surprise many to know that in our class of work, drilling holes as explained does not, all things taken into account, adversely affect the cost or speed of construction. The fact is, in punching a plate a gang of men is employed to handle it, and, although the process of punching is much more rapid than that of drilling, there are very many more men employed. In drilling plates, whether in their place of in the yard, under a radial drilling machine, one man with suitable tools can perform the whole operation without any assistance, or any handling or moving of the plate.

I have stated above that the process of punching is more rapid than that of drilling. This is true when comparing the punching and drilling of single plates. Punching must be done on one plate at a time, but it is often found possible to drill several plates at once. In such a case it is, of course, obvious that only the top plate requires marking off. It is at these times that the Swiss drill,

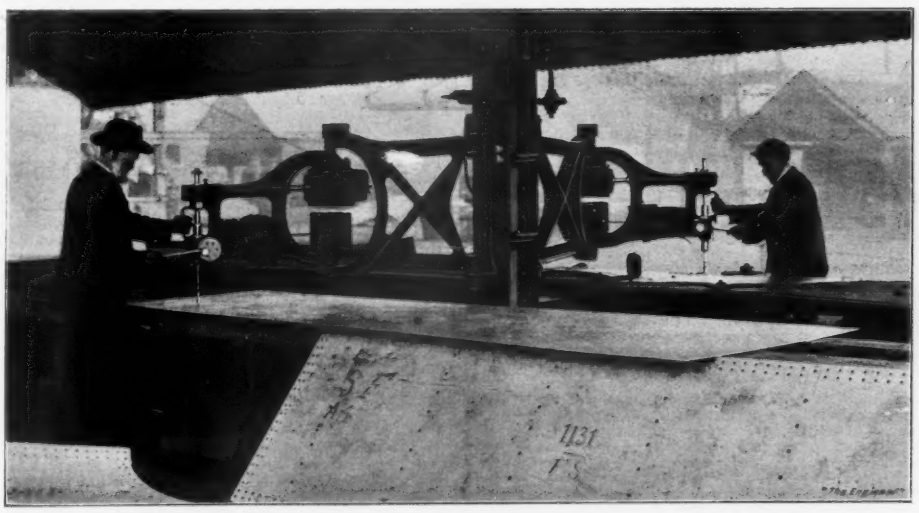


Fig. 3—ELECTRIC DRILLING MACHINE

with its one attendant, proves its extreme value. One single illustration must suffice. We have ourselves used these machines repeatedly on batches of eight plates bolted together. The average time taken to drill a ⅝in. hole through eight ⅞in. high-tensile-steel plates is less than forty seconds, the holes being, of course, exactly in the required position. No punching machine, with its attendant gang, can rival this.

A large increase in the drilling tackle of the yard is necessarily involved, but when driven by electricity or compressed air the tools are both simple and inexpensive.

Section VI.—Waterworks, Sewerage, and Gasworks—met on Thursday in the Council Chamber of the Guildhall, Westminster. Two papers were read. The first of these, on "Smoke Abatement," was by Mr. G. T. Beilby, and the second by Dr. S. Rideal on "Coal Gas Standards." With both of these papers we propose to deal in a future issue.

SECTION VII.

The Thursday meetings in Section VII. were opened by the chairman, Mr. Alexander Siemens, in the Council Room of the Surveyors' Institute, when a paper was read by Colonel R. E. B. Crompton, on

"APPLICATIONS OF ELECTRICITY TO DRIVING CARRIAGES IN TOWNS."

During the last year we have all noticed the very considerable development of motor cars in London. A large number of these are electrically driven—that is to say, they carry their motive power in the form of stored energy in accumulators which are charged at charging stations from the mains of the electric lighting companies.

In a paper on this subject recently read before the Institution by Mr. Henry Francis Joel, many interesting facts were brought forward. A table of comparative working costs of automobile vehicles was given, showing that the cost of working a four-passenger London cab was 15s. 4d. per day; a motor car worked by petrol 14s. 2d. per day, and a light steam car about the same figure; whereas for an electric cab or brougham the cost varied between 14s. and 17s. per day; at any rate, a good case was made for electrically-propelled vehicles.

Since the reading of that paper the development in electrical vehicles has been very considerable; in fact, they form the majority of the automobile vehicles now seen in the streets of London. It is probable that in two years' time the number in use will reach into thousands.

The principal points of interest in the working of these vehicles are the arrangements of the vehicles themselves with regard to the communication of the driving power from the motors to the road wheels, the choice and upkeep of the batteries which drive them, and the tires.

Transmission gear.—During the very trying winter we have passed through, in which a greasy, and hence dangerous, condition of the streets has been singularly unfavourable for automobile traffic—I allude to the danger from side slip—it is noticeable how well the electrical vehicles have stood this ordeal, and how few accidents have occurred with them from side slip. This is partly due to the fact that it is a comparatively easy matter to apply the driving power to the front wheels, which are also the steering wheels, and this undoubtedly constitutes one of the great advantages of electrical propulsion. Electrical vehicles also possess an important advantage over petrol or steam-driven cars in that it is so easy to apply separate power to each driving wheel that there is no necessity for the complication introduced by the use of differential gear. Up to the present, apparently the majority of electrical vehicles use tooth gearing, in spite of the fact that chains are undoubtedly easier to lubricate and to maintain in good silent-running condition than is the case with tooth gearing. The slight noise that is heard from these vehicles generally proceeds from this gearing, whereas the absolutely silent automobiles, a considerable number of which are being used driven by electricity and steam, generally use chain transmission.

Storage batteries used.—Up to the present the storage batteries used are invariably of the lead-couple type, either with electrodes made active by Plante formation or of the E. P. S. type, with various modifications in the form of the grids or supports used to imprison the active material and prevent it falling away from the backing under the influence of vibration. The forms of the plates are very various and, in some cases, very ingenious. Attempts have been made to use a zinc-lead battery in order to obtain the extra electromotive force from this couple, but so far with very modified success. A further modification, using cadmium, has also been tried. The Edison battery, about which so much has been written, in which iron and oxide of nickel have been used, has not yet been put into a workable form, although much is expected from it. Apparently, however, it is not necessary to wait for the invention of a new form of accumulator, as there are several forms already in use which work very well, and which can be maintained at a moderate cost, and are included in the foregoing working costs per day.

In the author's opinion, all that is necessary to reduce the cost of accumulators further is standardisation—that is to say, the supply of accumulators should be undertaken very much as the supply of fodder and forage for horses. Once standardisation of this class is carried out to such a point that standard boxes can be exchanged for others ready charged on the production of a subscription ticket, at a sufficient number of charging stations, the difficulties and risks of this method of mechanical propulsion become greatly lessened; in fact, they practically disappear. A good deal remains to be done in the direction of such standardisation, and there appears now to be an opening for a company having considerable capital to establish charging depôts where such standardised accumulators can be supplied to the owners of electrical vehicles.

Tires.—The cost of tire upkeep in this form of motor car has been found to be unexpectedly high, although a good many of them use the less expensive form, namely, solid rubber. This high cost of upkeep of tires is probably due to the vehicles being rather heavy, and probably also because the mileage run by them is very considerable. Most of the electrical vehicles are used as carriages, and are driven very regularly, so that the monthly mileage usually reaches a total in excess of that reached by touring vehicles. The electrical vehicles are used daily, and their mileage soon runs up. Also, probably on account of supposed facility in arranging the gearing, the wheels of these cars have in many cases been unnecessarily small, and it is known that the deterioration of solid rubber tires increases in proportion to the number of revolutions made by the wheels. Theoretically, solid rubber tires are a mistake, but on account of the heavy patent charges on pneumatic tyres, the latter do not at present compete with them in price.

Another matter is the extent to which the cost of electricity for charging these motors can be reduced, provided that the electricity is supplied during certain hours, during which the plant is generally only partially loaded, such as from 12 o'clock at night to 6 o'clock the following morning in winter, or 12 o'clock at night to 6 o'clock the following afternoon in summer. Prices as low as 1½d. per unit have already been mentioned; the price of 17s. a day quoted from Mr. Joel's paper is based on electricity at 4½d. per unit.

Colonel Crompton remarked, in conclusion, that he thought that the demand for electrical vehicles would shortly be enormous.

Sir E. H. Carbutt opened the discussion, stating that he had brought his electric brougham, and that it could be examined by any members who desired to do so. About two and a-half years ago he had used a touring motor car with great success. The total weight was 2½ tons, but he found the maintenance of tires very expensive. His present car was purchased from the Electromobile Company, who supplied various types, costing from £550 to £700 each. The owner of the vehicle then entered into an agreement with the company, which covered insurance against all risks, and included the cost of charging batteries, &c. He found that the annual expense was from £360 to £400. When touring about the country with his previous car he had been charged as much as 1s. per Board of Trade unit at certain charging stations in provincial towns. The weight of his present car was 26 cwt., and it had five speeds. He thought the life of the battery was about six to nine months.

Mr. Gatehouse began by stating that he had no financial interest in any manufacturing concern, and then proceeded to describe a new type of battery known as the Elieson-Bobinsky. The plates are composed of lead in thin ribbons, one ribbon being straight and the next corrugated. These are packed side by side and offer a large surface to the electrolyte. The cell with two positives and three negatives weighed about 22 lb. complete, and would give 100 ampère hours on a 5-hour discharge rate. He produced some of the actual plates, and gave a large number of details concerning tests which had been made.

Mr. Chambers said that electric carriages had been introduced eight years ago in Paris, and in this country we were somewhat behind the times. The expenses for town work should be calculated at £1 per day, which was approximately the same as that for a brougham and two horses. One of the chief difficulties was the great mileage run by these cars in towns. His company had fifteen cars at present, and in May one had been run 850 miles, thus making about 10,000 miles per year. Renewals of tires would cost about £100, garage £300, and the driver £100, making a total of £400 per annum, and he saw no possibility of reducing this amount. He knew at present of two contracts with London supply companies for current at 1½d. per unit. This was, however, at high potential, and a motor generator was necessary, so that the actual cost was about 3d. per unit.

Mr. H. F. Joel said he appreciated the author's remarks that a generous spirit should actuate builders of electric cars, so that standardisation might become possible. He recently had to repair a German car, and found it very badly built. He thought it better to apply driving to the back wheels rather than to the front ones, and preferred chain driving to the use of gearing. He handed in a table showing the relative weights, prices, and probable life of certain batteries. One of these was a light battery, weighing 6 cwt., and costing £42, for use in a car weighing 30 cwt., with a duty of 5000 ton-miles, and capable of receiving 110 charges; the other a heavy battery, weighing 12 cwt., costing £72, to be used in a car weighing 40 cwt., with a duty of 7330 ton-miles, and a life of 220 charges. He allowed 60 per cent. per annum depreciation on the light battery and 40 per cent. on the heavy battery, and on this assumption the carriage with the light battery would cost 13s. 9d. per day, and that with the heavy one 15s. 1d. per day. It therefore appeared preferable to use a light battery, and allow for rapid depreciation.

Mr. P. D. Northey thought the batteries were not likely to be much improved, and he could not agree that such a large number of charging stations was necessary as had been recommended by some of the speakers. One client might bring in a battery heavily sulphated and receive a practically new battery in its place. This was the great risk to be taken by the company. He thought it preferable to drive on the front wheels, and it was quite easy to put the principal load on these wheels. He also preferred to use one motor on a live axle without differential gearing, and he thought the Fulmen a very good cell, and it would give 12 watt hours per pound when new. He agreed with another speaker that there was always an opening for a company with considerable capital to supply and charge electric vehicles.

Mr. Thomas Parker said that the cell referred to by Mr. Gatehouse was remarkably like the Blot battery, which he had introduced into this country some years ago. He had himself used an electric car and spent some thousands of pounds in experimenting. The great difficulty was the loss in capacity of the battery by over-discharging. His firm some years ago had installed the Bournebrook accumulator tramway line at Birmingham and the diminution in capacity of the batteries was enormous. His opinion was that batteries were useless for a hilly country, but were serviceable on level roads. The cost of the electrical work in a carriage was only about £150. Why, therefore, should the cost of the broughams be so excessive? Over-discharging of the batteries must be prevented if a reasonable life was to be obtained.

Mr. Shoolbred said there was at least 200 stations in this country where batteries could be charged with a potential of 200 to 250 volts.

Mr. Erskine said the annual cost of an electric

brougham if obtained from the carriage companies was £350 to £400. He knew of a case where a carriage was charged from a private installation. This carriage ran 500 to 600 miles per month; current was supplied at 2½d. per unit at 200 volts; the total cost was £2 1s. 4d. per month—say, £24 a year. The carriages were usually built to be charged at 80 to 120 volts. Why could not the batteries be made for charging at 200 volts?

Mr. Joly gave particulars regarding the sizes of the various batteries, and recommended standardisation. He had tested a vehicle weighing 1·7 tons, and had found that in descending a steep hill it had required as much as 290 watt hours per ton mile.

Mr. L. Preece remarked that forty cells were usually adopted, and it was difficult to arrange to charge at 200 volts.

Colonel Crompton then replied, and said that it appeared that the present cost of running an electric brougham was 9d. per mile; therefore they could only be used by the rich. Mr. Joel had stated 6½d. per mile, and Mr. Erskine's figures worked out at 1d. The supply companies would give current at 2d. per unit, which would be a ½d. per mile. Then there would be 1d. per mile for maintenance of cells, garage charges ½d., tires ½d., and the man 3d. per mile. The chief point was that with an electric vehicle there was no necessity for a man, as it could be driven by the owner. If horse traffic could be superseded by electric vehicles, the speed in the street could be raised from the present five miles to, say, ten miles an hour.

The next paper taken was by Mr. E. W. Monkhouse, on

"TRANSMISSION AND DISTRIBUTION BY SINGLE-PHASE ALTERNATING CURRENT."

The question of electrification of railways has been, and is receiving much attention and consideration from the directors of railways and their advisers, and the question of cheap power is receiving the attention of numerous other people.

The problems which have to be solved are:—The cheap generation of electrical energy; the transmission thereof; and the utilisation thereof at the end of or along the line.

The necessity for transmission of power over long distances arises from the fact that it is often inconvenient or inadvisable, from the point of view of economical generation of energy, to have generating stations near the points at which energy is to be used. If the distance is great it is not possible to transmit at low-pressures, as, if this were done, the amount of copper which it would be necessary to use in the transmission line would be prohibitive.

Where it is not necessary, owing to circumstances, to generate and transmit at more than about 1500 volts, the electrical energy can be generated by continuous-current machines, but above this pressure continuous-current machines give trouble, and it becomes necessary to employ machines which generate alternating current.

It is a well-known fact that for use in lamps there is nothing to choose between continuous and alternating current, provided the frequency of the latter is high enough; so that the question is narrowed down to one of transmission and use in motors. The transmission of electrical energy over long distances for power purposes is being successfully accomplished at the present time by means of alternating currents, but these are usually polyphase. The alternating current so transmitted is generally converted into continuous current either by means of polyphase motors driving continuous-current dynamos, or by means of rotary converters, before it is used by the consumer. The numerous conversions which the original source of power has to go through in such a case all serve to lower the efficiency of the system, and it is therefore very desirable that the number of conversions should be cut down to a minimum. This means that we must, as long as we are compelled to use alternating current for transmission, have motors which are capable of working satisfactorily with it, and motors which will work with a current at as high a voltage as possible, so that transformers are not necessary, and the copper in the transmission lines may be kept down to a minimum. An ideal system would be one in which there were no transformations of voltage between the dynamo and the motor. This means that for very long distance transmission, both dynamos and motors would have to be wound for very high voltages.

The generation of electrical energy at high voltage (10,000), and the transmission at the same voltage, is being effectively carried out by the London Electric Supply Corporation; and that it is possible to use high voltage in motors is shown by the fact that in 1899 a stationary motor working at 10,000 volts was in use at the General Electric Company's Works at Schenectady, U.S.A., driving the machinery of a portion of the shops, and appeared to be running satisfactorily; and also that lately the Valtellina Railway in Italy has been constructed, and on this the voltage at the motors is 3000.

The raising of the voltage of transmission and the voltage at the motors points to the necessity for having all connections and apparatus as simple as possible; and the use of single-phase alternating currents in place of polyphase would tend to this end, as all switches, instruments, &c., are reduced to a minimum. On a single-phase alternating system the switch-boards at the generating and sub-stations are much simpler and less costly pieces of apparatus than on polyphase systems, for only single-pole switches and fuses are required in place of triple-pole; the instruments are much fewer and the connections are of the simplest character. The transformers also are simpler. It follows, as a matter of course, that the cost of up-keep is much less, and also that the chances of breakdown owing to failure of apparatus are considerably reduced.

The desirability of employing a single-phase system rather than polyphase for transmission of energy from the generating station to the sub-stations is therefore apparent, but this is greatly emphasised when the question of the line from which current for traction purposes has to be collected is considered. All writers on the subject of electrical working of long-distance heavy railways are agreed that, owing to the fact that the line voltage could only be comparatively low if continuous currents were used, the conductors for carrying the large currents necessary for working the trains would be of a prohibitive size unless sub-stations for feeding current into them were placed at very short intervals along the line, and this, of course, would involve not only a large capital outlay, but also a large staff of men and consequently heavy running expenses, and also that the collection of such large currents would be a matter of great difficulty, and that, therefore, the currents used must be high-tension alternating.

This being the case, we have the choice of using single-phase or polyphase currents, and it will be at once apparent that on the score of simplicity the single-phase current is the much more desirable; for, assuming that the rails are used as one conductor, as is the case on the Valtellina Railway, it is only necessary to have one conductor in addition to these, and consequently one collecting device, instead of two conductors and two collecting devices, as is necessary with a polyphase system. Having only one conductor makes junction work extremely simple, whereas with two conductors this is extremely complicated; and as, for reasons already given, high voltages are necessary, complications are to be avoided. Moreover, the whole of the collecting and controlling gear is much simpler.

The difficulties hitherto experienced in starting alternating-current motors under load, and in getting such motors to deal satisfactorily with great and sudden changes of load, would appear to be the principal reasons for adopting polyphase alternating currents for motor work as against single-phase. The single-phase motor of the present day, however, can be started under load, and will deal satisfactorily with very sudden and great variations in the load.

The question of speed regulation is one which affects polyphase and single-phase motors alike; and in a paper read before the Institution, Messrs. Mordey and Jenkin gave descriptions of methods that had been proposed for dealing with this. All the methods proposed involved the use of some sort of rotary transformer for transforming alternating current into continuous current, and then using it in the motors, and this involved the provision of sub-stations by the side of the line, or the carrying of much machinery besides the motors on each train.

Mr. Lamme, in a paper read before the American Institution of Electrical Engineers, gives a description of the Washington, Baltimore and Annapolis Railway, which is to be a single-phase overhead alternating-current system, in which the motors are to be worked by the single-phase alternating current at 3000 volts. The speed control is to be effected by an induction regulator, thus avoiding the use of resistances which absorb power.

The advantages of transmission of power by single-phase alternating current are so apparent that it only remains for a suitable motor to be produced which will give as good results both as to regulation and efficiency as are given by the best continuous-current motors, to ensure the system being used for long-distance power transmission in the future.

Mr. Alexander Siemens observed that the last paragraph in the paper raised the most important question. The chief difficulty was in the starting and stopping of the motors, but no doubt the single-phase alternating motor would be satisfactory for long-continued runs.

Mr. E. R. Dolby remarked that his firm had been anxious to obtain six passenger lifts for hospital work to be worked from a single-phase alternating supply, and after application to three or four of the principal lift makers he had found it practically impossible to get what he considered a satisfactory lift—difficulty arising chiefly in the starting and stopping mechanism.

Mr. H. E. J. Burstall stated that the London Electric Supply Co., at Deptford, had been testing a 10 horse-power single-phase motor and found that it would give about 80 per cent. efficiency, and could be started upon the load. Single-phase 100 horse-power motors were being used to drive dynamos. They had been experimenting with a Deri lift motor, and although the efficiency might not be very high the switching was fairly simple. The frequency of the supply was 86 periods a second.

Mr. A. H. Preece had put down a number of motors on the Hammersmith supply, which had a frequency of 50 periods, and at Fuller's Confectionery Works, off the same supply, they had a number of single-phase motors varying in size from 2 to 10 horse-power, and these gave very satisfactory results. Messrs. Witting Bros. had supplied a 30 horse-power motor for the circulating pumps, and also a similar motor for the jib crane.

Dr. Hopkinson doubted the advantages suggested by the author. A larger amount of copper would be needed for single phase transmission than was required for three-phase work, and the necessity for synchronous working was a serious disadvantage.

Mr. Broadbent remarked that it was difficult to vary the speed of single-phase motors, and he had had considerable experience with them in driving planing machines. On the Baltimore Railway, continuous-current motors with laminated fields were supplied with single-phase current, and in this way speed control could be obtained. He should like more details of the induction regulator mentioned by the author. He considered that a mere choking arrangement was of no use.

Mr. Shoolbred thought that the author regarded continuous current as placed in an inferior position. His own opinion was that for distances of five to six miles continuous current should be used. It would be awkward to have both continuous and alternating plant in the same station, and the complications of polyphase current were considerable.

Mr. Siemens thought the alteration of speed was difficult with alternating currents, and said that he read a paper in 1891 giving details of experiments on single-phase motors, but did not proceed further with the matter. The Westinghouse Company had now taken up the subject, and made a success of it, and great credit was due to them.

Mr. Monkhouse then briefly replied, stating that the Westinghouse arrangements could not be published, as the details had not yet been patented. His paper did not deal with railways of three or four miles in length, but with main line systems.

THE JUNIOR INSTITUTION OF ENGINEERS.—There will be a visit of the members of this Institution on Wednesday evening, June 24th, at 6·30 p.m., to Messrs. Spiers and Pond's model laundries; art dyeing and chemical cleaning, and steam carpet beating department, 140, Battersea Park-road. There will be a meeting on Friday, 25th June, at 7.30 p.m., at the Finsbury Technical College, by kind permission of the authorities, and on the invitation of Mr. R. P. Howgrave Grayham, who will deliver a lecture, illustrated by experiments, on "High frequency Electric Discharges."

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Engineer Rear-Admiral G. H. Weeks has been placed on the retired list, to date June 12th. Engineer commanders: J. J. Stuart, to the Pembroke, for the Endymion; J. R. J. Pedrick, to the Vivid, for the King Edward VII.; W. T. Hocken, to the Cambridge, for the Conqueror, to date June 9th; C. Dawe, to the Hood; J. S. Fussell, to the Vivid, for the Collingwood, to date June 23rd. Engineer lieutenants: A. R. Anderson, to the Hood, to date June 25th; A. W. Sutton, to the Duke of Wellington, to assist Engineer Captain of Dockyard Reserve, to date June 9th; W. Ryan, E. J. Campbell, and W. W. Read, to the Hyacinth, to date July 1st; G. N. Lealie, to the Vivid, for instruction of engineer cadets, to date June 10th; A. S. Crisp, to the Pembroke, for the Assaye, to date June 26th; H. Abbott, to the Mercury, to date June 18th. Engineer sub-lieutenants: A. Pettman and W. G. Main, to the Hood, to date June 25th; P. L. Butt, to the Hyacinth, to date July 21st. Artificer engineers: D. J. Leary, to the Hyacinth, to date July 21st; P. N. Flannigan, to the Empress of India, to date June 10th; O. J. Smale, to the Hood, to date June 25th. Acting artificer engineer: R. Down, to the Hood, to date June 25th.

RADIUM.

THE Royal Institution is justly celebrated, because—among a number of other things—in its various lectures and discourses one may always depend upon hearing the last word in connection with the latest scientific discovery. Moreover, those who are invited to give the lectures and discourses are almost invariably just the very people who should give them. Last Friday evening was far from being an exception to the general rule, for Professor Curie—co-discoverer with his wife of the new element—delivered a discourse on "Radium." Professor Curie spoke in French, and he first of all explained that radium was capable of giving out heat rays sufficient in quantity to permit of measurement of rise in temperature by means of a thermometer. Moreover, it was apparently capable of doing this without suffering diminution itself in either bulk or weight. The emanations affect photographic plates through opaque substances much in the same ways as do the Röntgen rays, though it is noticeable that the effects produced by the former are not nearly as sharp as are those obtained with the latter. Radium, too, will render some bodies—such as sulphide of zinc and platinocyanide of barium—into proximity with which it is brought, phosphorescent. Moreover, it did not lose this extraordinary property when its temperature was lowered to that of liquid air, and it, as far as has yet been discovered, is capable of causing these phenomena for indefinite periods, without any loss to itself or any diminution of activity.

Another attribute possessed by this element, or its compounds—for it was with the chloride and bromide of radium that Professor Curie was experimenting—is its ability to render air a conductor of electricity. When brought near either of the terminals of an induction coil between which sparks were passing, the sparking ceased. Apparently the infinitesimally small particles thrown off in the radiations actually render the air a conductor. Then, too, when brought near a charged electroscope it has the power of discharging it.

Prof. Curie then described the different radiations given off by the radium compounds, and classified them in accordance to their behaviour under the influence of a magnetic field, their power of penetration, &c., and went on to explain that in addition to these radiations, emanations possessing the same properties as the substance itself were given off. These emanations possess many of the properties of gases. They could, for example, be sucked through a tube. They could also be condensed by the action of intense cold, and would diffuse again when the temperature was raised. As an example of one of the effects produced, two vessels, one containing sulphide of zinc and the other radium chloride, were connected by a tube in which had been fixed a stopcock. As long as this latter remained closed no effect was produced on the zinc sulphide, but this substance at once became luminous as soon as the stopcock was opened. The emanations, like the substance from which they come, can also discharge electrified bodies.

That radium actually did give off heat rays was demonstrated by a striking experiment with what the professor termed a liquid air calorimeter. A vacuum flask was so arranged that the quantity of air boiling off in a given time from some liquid air contained in it could be accurately measured. Into this flask were successively lowered a small piece of glass and a small vessel of like size, containing a small quantity of a radium substance. It was shown that the quantity of air coming off in the second case was very much greater than it had been in the first case—the times in both instances being the same.

Before concluding, Professor Curie alluded to some of the other characteristics of radium. He explained that it was obtained from pitchblende, in which mineral it was present in very minute quantities. We believe that Sir William Crookes has succeeded in extracting a gramme from a ton of pitchblende. The rays will discolour paper, give glass an abiding violet tint, turn oxygen into ozone, yellow phosphorus into the red variety, and mercury chloride into calomel. Some of these powers were exhibited. Finally the lecturer gave some account of the experiments which he and his wife had carried out, and which had led up to the discovery of radium and other similar bodies. He also made mention of a few of the speculations as to the possible gradual transformation of the elements, suggested by the already known properties possessed by this wonderful substance.

ELECTRICITY AT NIAGARA FALLS.

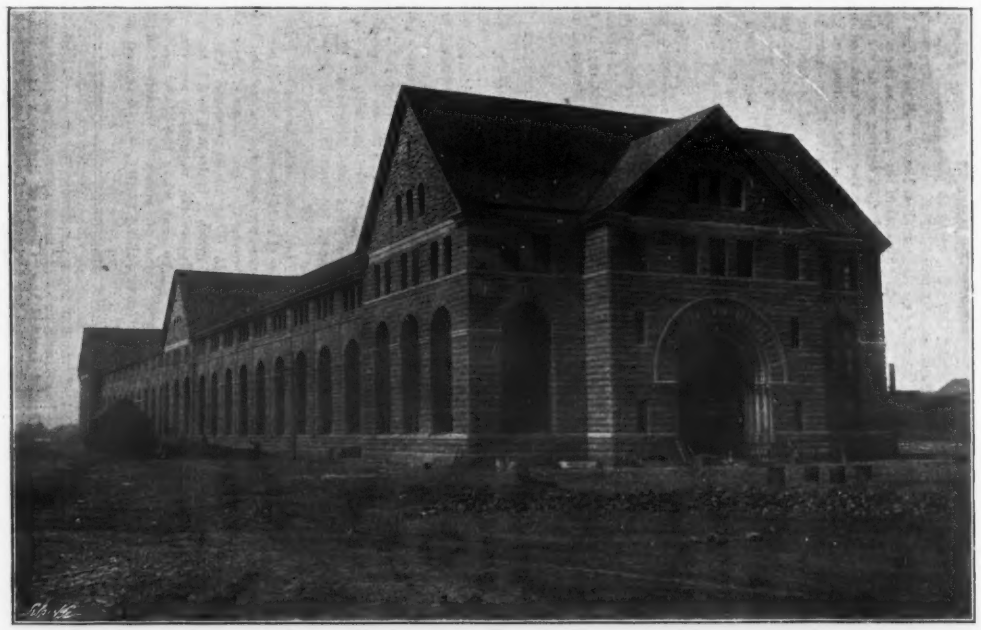
THE Niagara Falls Power Company has completed the installation of the first six generators in power-house No. 2, and while these machines are somewhat similar in outline to those erected in power-house No. 1, they differ in appearance from the fact that the iron bridge over the machines in power-house No. 1, has been omitted in building the machines in power-house No. 2. This change is effected by placing the collector rings at the bottom of the dynamo shaft instead of at the top. The photographs reproduced on pages 647 and 650 give a very accurate idea of the style of these new and notable generators.

Power-house No. 2 is considered a beautiful building. Its exterior appearance is very similar to that of power-house No. 1, with the exception that gables break the roof at the centre and ends. The stone used is identical with that used in No. 1, and the general idea which won such favour in the original station has been carried out in this new power-house. The new station stands on the opposite side of the inlet canal to that occupied by power-house No. 1, and it is a little to the rear. It is built over a wheel-pit that is 463ft. 8in. long, 18ft. 6in. wide, and 178ft. 6in. deep. This new wheel-pit is closer to the river than the old pit, but the two wheel-pits have a connecting passage way at a depth of about 130ft. from the surface. This connecting tunnel is for the use and convenience of the employés. The new wheel-pit has room for eleven units of 5000 horse-power each. The water from the second wheel-pit installation is carried to the original main tunnel by an extension that is about 600ft. long, making the total length of the tunnel of the Niagara Falls Power Company 7436ft. It will be recalled that this tunnel is built in form of a horse shoe, 21ft. high and 18ft. 10in. wide, and is lined with brick from end to end.

In wheel-pit No. 2 the turbines differ from those in wheel-pit No. 1. When wheel-pit No. 1 was built double turbines were installed, but in wheel-pit No. 2 the turbines are of the internal discharge type, and have the waste water carried off through draught tubes, and this, it is stated, adds about 10 per cent. to the effective head. These turbines were designed by Escher, Wyss and Co., of Zurich, Switzerland, but were built and installed by the I. P. Morris Company of

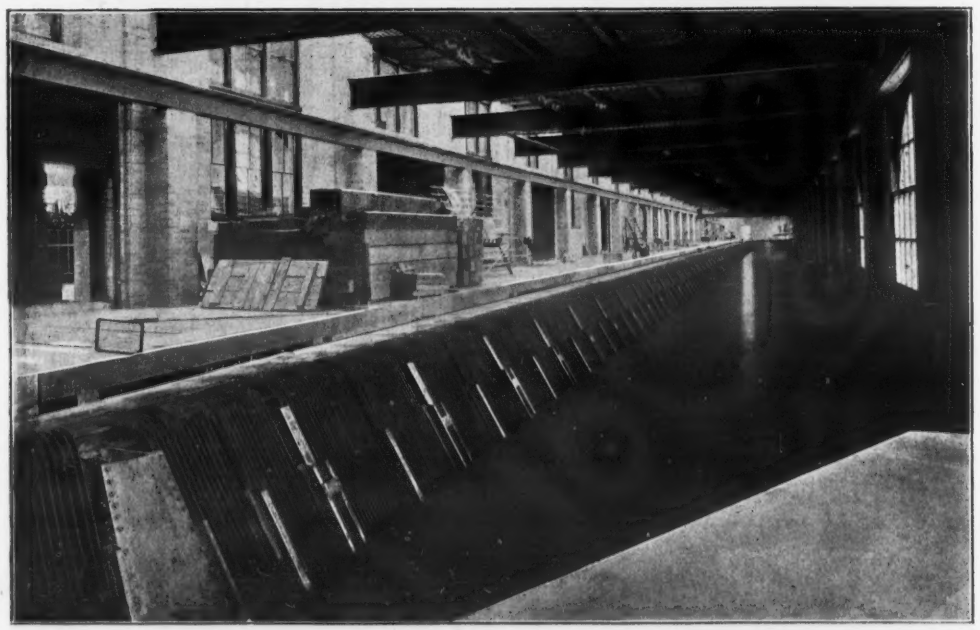
NIAGARA FALLS—POWER HOUSE, No. 2

(For description see page 646)



EXTERIOR OF POWER HOUSE

ENLARGED TRANSFORMER STATION



INTERIOR OF FOREBAY

INTERIOR OF GENERATOR BUILDING

Philadelphia. The governors were built by A. Falkenau, of Philadelphia, but were also designed by Escher, Wyss and Co. These governors are of the oil-pump operated type.

Though a comparatively few years have passed since the development in connection with power station No. 1 was commenced, it is evident in the electrical equipment of power-house No. 2 that electrical science has made notable advances in this brief period. There is closer generator regulation; the feeders are protected with automatic oil circuit-breakers, and the eleven generators to be installed in power-house No. 2 will all be controlled from a single switchboard, whereas power-house No. 1 has two switchboard structures. The General Electric Company is furnishing the electrical equipment of this new power-house. The generators are of 5000 horse-power each, and are wound for 2300 volts, two-phase, 25 cycles, at 250 revolutions per minute. This makes it possible to have an interchange of service between power-house No. 1 and power-house No. 2.

This new station is to have two types of generators, the first six portrayed in the illustration being all of one type. These are of the external field type, with nickel steel revolving magnet rings, but, as stated, the bridge over the top has been omitted. In the matter of regulation they are said to be nearly three times as close as those in power-house No. 1, a fact that ensures constancy of voltage under variations of load; and also reduces to a minimum the unbalancing of the voltages on the different phases by the differences in loads. The system of ventilation in the new machines is also quite different. Actuated by centrifugal effort, the air enters the machine at the bottom inside the armature shell. It then passes outward through air ducts in the armature core, cooling both the iron and the winding. Continuing, it passes radially between the layers of the field winding to an annular space in the rear of the field coils, then outward through holes in the magnet ring. Some of the air also passes through ventilating holes at the top of the ring.

The five remaining generators to be placed in this station will be of the internal revolving field type, wound for 2300 volts, 25 cycles, two-phase, and will be operated at 250 revolutions per minute. They will have the same regulation as the six already installed. Compared with the generators of external field design, these last five generators will cost less to build, will be more simple to handle, and the parts will be more accessible. It will be possible to operate all the machines in parallel.

In the construction of wheel-pit No. 2 a compartment or chamber was excavated near the bottom, and in this the exciter plant has been installed. This equipment consists of four 150-kilowatt compound-wound vertical shaft 220-volt exciters, each of which is coupled to an independent turbine. Each exciter turbine has a separate governor, and the speed is 750 revolutions per minute.

The switchboard structure consists of a gallery placed near the middle of the floor, and on it are mounted thirty-six separate controlling panels, eleven generator, twenty-two feeder, one exciter, and two interconnecting panels. All the switching is done on these panels by means of relay switches, and these are placed in distinctive relation to one another, and in such relation to imitation bus bars that the connections are clearly indicated, rendering it difficult to make a mistake. All the switches in power-house No. 2 are of the General Electric electrically-operated oil-break type, and all synchronising is done by means of a Lincoln synchroniser.

One of the notable improvements in connection with power-house No. 2 is the covered forebay structure built along the canal side of the main building. This is about 40ft. wide, and extends nearly the entire length of the structure. All the racks in front of the penstock mouthpieces are thus under cover, the water entering the forebay from the canal through arches in the outward wall. This covered forebay structure will shelter the men working over the racks in winter, and as the water enters the forebay below the normal level, the system should be a protection from floating ice in the inlet canal.

Mr. William A. Brackenridge is the resident engineer of the Niagara Falls Power Company, and it was under his careful supervision that the great plant was erected. Mr. Brackenridge is thoroughly familiar with all features of the wonderful Niagara development, and to his ability as an engineer are due many of the improvements made in power-house No. 2. Mr. H. W. Buck is the electrical director of the Niagara Falls Power Company, and to his skill credit must be given for important electrical features of great value.

A contract has been made between the Toronto and Niagara Power Company and Anthony C. Douglass for the construction of a new tunnel for the development of 125,000 horse-power on the Canadian side at Niagara Falls. This tunnel will have a length of 2100ft., and it will be 25ft. high and 18ft. wide. It will be built under the provisions of a franchise granted the Toronto and Niagara Power Company by the Commissioners of Victoria Park. It will extend from the company's wheel pit to the lower river or gorge. Its route will carry it under a section of the river bed washed by the upper rapids of the Niagara, and the outlet or portal will be behind the falling water of the Canadian or Horseshoe Fall. In the construction of the present Niagara power tunnels it was possible to sink a shaft near the centre of the route in order that the work of driving the tunnels might progress from this point as well as from the ends. As the current of the river is very swift over the proposed route of the new tunnel, it will be impossible to carry out this method of working; but a shaft will be sunk in close to the shore on the Canadian side, and from the bottom of the shaft a lateral tunnel will be driven out under the river to the line of the main tunnel. When this point is reached headings will be driven toward the wheel pit and also toward the lower river; the excavated material to be carried to the surface along the lateral tunnel and up the shaft near shore. The sinking of this shaft and the driving of the lateral tunnel will be quite a work in itself. It is expected that it will require two years to drive the new tunnel.

The power station of the Toronto and Niagara Falls Power Company will be situated in Victoria Free Park, a short distance above the station of the Canadian Niagara Power Company, but below the forebay of the Ontario Power Company, and it will therefore take its water supply from the river between the other two intake points. As the portal will be behind the Horseshoe Fall, the stream of water that will pour out of the tunnel will not be in full view, but the water will plunge right into the boiling waters at the foot of the mighty precipice. The new tunnel will be lined from end to end.

NEW TYPE GENERATOR, NIAGARA

Mr. Anthony C. Douglass, who has received the contract, has had an extended experience in the development of power at Niagara. He was connected with the sinking of the original wheel-pit of the Niagara Falls Power Company on the New York side of the river, and he drove the tunnel of the Canadian Niagara Power Company on the Canadian side. This latter tunnel is 2200ft. long, and it is now being lined. The portal will have exceedingly heavy masonry work, and this will soon be placed under the direction of Contractor Douglass. As Mr. Douglass has just finished driving the tunnel of the Canadian Niagara Power Company, he will be able to transfer his plant to the tunnel of the Toronto and Niagara Power Company close by—a fact that gives him a marked advantage, for any other contractor would have to assemble his plant. For this reason Mr. Douglass is all ready to begin the new tunnel at once, and as it will parallel the tunnel of the Canadian Niagara Power Company, he is thoroughly familiar with all the obstacles and nature of the rock he is likely to encounter. The contract price for driving the new tunnel is understood to be about 575,000 dols. No other man has been connected with works that have pierced the Niagara rock to the extent that Mr. Douglass has. The contract for sinking the wheel-pit of the Toronto and Niagara Power Company has not yet been awarded. At present the company has a force of men engaged in building wing dams and cofferdams in front of its power-house site, and soon the work of sinking the pit will commence.

Messrs. Dawson and Sims have broken the first section of the wheel-pit of the Canadian Niagara Power Company through into the tunnel, which extends underneath it. This company has been awarded the contract for extending the wheel-pit to its full size. The present section is 266ft. long, 21ft. wide, and 170ft. deep. When completed the pit will have a length of 480ft.

The Ontario Power Company's project is progressing with all due speed. The excavation in which the covered flume will be laid through Victoria Park is being made. This flume will be a pipe about 18ft. in diameter. Near Table Rock work has started on the forebay excavation, and down in the gorge men are busy on the power-house site.

At no point in the Dominion of Canada is there greater industrial activity than on the Canadian side at Niagara Falls. Hundreds of men are at work on the three wonderful projects for the development of power, and now that fine weather has arrived the number of hands will be increased daily. Each new contract adds to the men employed, and beautiful Victoria Park is badly torn up by the works in progress there. For years the heavy blasts have been echoing up and down the Niagara gorge, and for over two years longer these mighty rents are to be made in the rock.

All who have visited Niagara Falls, or are familiar with the various power development projects there, know that the oldest and one of the most valuable power rights is that held by the Niagara Falls Hydraulic Power and Manufacturing Company. This company, it will be recalled, owns a surface canal that extends from the upper to the lower river, a distance of 4400ft. This canal runs right through the southern part of the city, and the right of way enjoyed by the company is 100ft. wide.

When the present owners acquired the property, the resources of the waterway had been but little developed, but for the past twenty-five years there has been hardly any cessation of operations in the enlargement of the canal. Some years ago the Erie Railroad erected a passenger station and train shed on the canal banks between Second and Third streets, and this was allowed to stand until the demand on the canal made it imperative that a greater water supply be obtained. Then the Erie was ordered to vacate the property, the train shed and depôt being moved a block or two to the east. When this was done, the owners of the canal began cutting the bank away to give the canal the full width of 100ft. at that point.

Further up the canal a heavy wall is being built to hold back the bank. Several of the plants on the power company's property have been enlarged during recent years, and there is a brisk, active demand for the power generated in the station at the water's edge in the gorge. Several of the mills and factories on the canal lands have their own wheels, but the main part of the flow of the canal is used to operate the turbines in the station in the gorge, the canal emptying into a basin from which connecting canals carry the water to a forebay close by the edge of the high bank, from which point it goes to the wheels through huge penstocks.

The foundation for a new power-house is being cleared in the gorge, at the water's edge, a short distance down stream from the present station. The development in this station will be notable. To supply the necessary water to the turbines in the new station, the canal basin will be extended northward several hundred feet. It is notable in connection with this project that it is the company's practice to do its work by the day, awarding no contracts on the enlargement work. Mr. Ross Coddington is superintendent, and has charge of the construction gangs.

DOVER HARBOUR.

IN our last impression we gave an illustrated account of the New Dover Harbour works, which were visited by a party of members attending the Engineering Conference. To-day we give, on page 643, two further engravings, which are interesting as showing some of the methods employed in the carrying out of the construction. Fig. 1 shows the temporary staging for the Admiralty Pier extension, with the Goliath cranes used in building the permanent structure. Fig. 2 shows the block yard on the east reclamation. In this there is a platform which receives the ballast from the inclined railway, mentioned in our last issue, and the cement from the cement store, and delivers it to electrically-driven travelling concrete mixers, which run up and down over the block moulds, mixing the concrete as they go. Some of these are to be seen in the foreground. They are so arranged that, as they arrive over the moulds which it is desired to fill, the concrete may be allowed to fall into the moulds by gravity. The moulds are constructed so that when the blocks are set the wooden sides may be taken to pieces to permit of the blocks being raised by the travelling gantry, which is also shown in the engraving.

LIGHT RAILWAYS ACT, 1896.—The Board of Trade have recently confirmed an Order made by the Light Railway Commissioners and entitled the "County of Middlesex Light Railways (Lands) Order, 1903," authorising the County Council of Middlesex to take lands for widening roads, on which light railways will be laid, in the parishes of Edgware, Finchley, Friern Barnet, Hendon, Kingsbury, Little Stanmore, Southgate, Tottenham, Willesden, and Wood Green, in the County of Middlesex.

RAILWAY MATTERS.

THE Abyssinian Railway is now finished from Jibutil to Adis-Harrar, a distance of 306 kilometres.

THE Belgian Chamber has passed the Bill suspending for fifteen years the Government's option of purchasing the Congo Railway.

DURING the past half-year the Secretary of State for India has entrusted the working of the Agra-Delhi chord line, 120 miles long, to the Great Indian Peninsula Railway Company.

THE longest railway journey that can at present be undertaken in Australia is from Cunnamulla, in Queensland, to Oodnadatta, in South Australia, the distance being 3014 miles.

THE new line constructed by the Great Eastern, Midland, and Great Northern railways between Lowestoft and Yarmouth will, it is said, be opened for traffic on Monday, July 13th.

THE stone parapet on the Glasgow and South-Western Railway, near Thornhill, which is over 100ft. high, has collapsed at one end. The structure is to be removed and replaced by an iron viaduct.

ACCORDING to a Reuter's telegram from Bulawayo, Sir Charles Metcalf, consulting engineer to the Rhodesian railways, has definitely stated that the railway will reach the Wankie coalfields in August.

SINCE the requisite amount of money to construct the Hedjaz Railway has not been subscribed, the Sultan is said to have approved the project of forcing all Mahomedans to contribute, the minimum sum being five piastres.

IN the House of Commons on June 18th, says the *Times* correspondent at Ottawa, Mr. Blair, Minister of Railways, expresses the view that the Grand Trunk Pacific Company would utilise the Canadian Northern Railway as part of its main line.

THE London and North-Western Railway Carriage Works at Wolverton have now upwards of 4000 men working only 3½ days a week, owing to scarcity of work, a thing which has been unknown for the past sixteen years. It is proposed to run the Newport-Pagnell branch line by electricity.

REUTER'S correspondent in Liverpool understands that the Southern Nigerian authorities intend to construct a light railway for passenger and freight traffic from the waterway of Sapelli to Benin City, a distance of 27 miles. The road is already made. Large ocean-going steamers now go up to Sapelli.

THE whole train service of the Central London Railway is now being worked on the multiple-unit system, the locomotives having been completely withdrawn. It has been found possible to run several more trains on the line under the new system, and the frequency of the service is correspondingly increased.

A MEETING of the shareholders of the South African Netherlands Railway Company was held at Amsterdam on the 22nd inst., at which it was decided—says a Reuter's telegram—that no dividend should be paid. The report and balance-sheet were approved, and the retiring members of the committee were re-elected unanimously.

MR. GEORGE WHALE has been appointed chief mechanical engineer to the London and North-Western Railway, with head-quarters at Crewe, from July 1st, in succession to Mr. F. W. Webb, who is retiring from the service on that date. All communications relating to the business of the locomotive department to be addressed accordingly.

A NOVEL tramway, along the front of the cliffs, is to take the place of the Brighton sea-going car, and is to run on to Rottingdean. Parliamentary powers for the substitution were obtained last session. Plans have been passed by the Board of Trade, and provisional estimates show that the novel tramway can be constructed for something like £20,000.

IT was expected that from Monday last trains would be running from Ealing to South Harrow on the Metropolitan District Railway Company's next extension, that line being then opened to the public for the first time. We gather, however, that a slight landslip, due to the recent rains, prevented the line being used in its entirety, though trains were run to take visitors to the Royal Show.

As the Midland Scotch express was nearing Leicester the other night six large bullocks suddenly appeared on the main line. The driver of the train applied the brake, but as the train was running at sixty miles an hour it dashed into the bullocks. The train was violently shaken. Three bullocks were killed instantaneously, and the other three were badly injured. The train stopped twenty minutes before the remains could be dragged clear of the line.

THE Great Northern Railway Company on Monday night started an Institute, which it has erected at East Ardsley, near Leeds, for the benefit of the men on the line. It is the first attempt by the company of the kind. The Institute is adjacent to the engine shed, and will accommodate about 200 persons. Mr. Reginald Wigram—Messrs. John Fowler and Co.—opened the Institute, and promised to add to the library. The directors were, he said, anxious to help the men to help themselves. Mr. B. Holgate, Leeds, delivered an address on Technical Education.

THE new line which brings Harrow, Sudbury, and Alperton into direct communication with the City is about five miles in length. In all there will be six stations on it, viz., South Harrow, Sudbury Hill, Sudbury Town, Alperton, Park Royal, and North Ealing. Park Royal will serve the new show ground of the Royal Agricultural Society. During the progress of the show, trains have been run at frequent intervals, now a half-hourly service will be provided over the new line in conjunction with the existing service of the District Company to Ealing. Passengers for the new line will change at Mill Hill Park or Ealing Common stations.

THE special express train of ten bogie cars, drawn by two engines, which on Friday made the journey between Euston and Glasgow with only one stop, at Carlisle, left Edinburgh at 1.55 on Monday afternoon for Euston, the intention being to cover the 400 miles between the English and Scotch capitals with one stop. This entailed a continuous run of 100⅝ miles over the Caledonian line from Edinburgh to Carlisle, followed by another continuous run of 299¼ miles from Carlisle to Euston. The express, which traversed the first section of the run in 116 minutes, left Carlisle at 3.59, drawn by two engines, and passed through Crewe at 6.54, or one minute before time. Euston was reached at 10.1.

A COLLISION, fortunately unattended by serious results, took place in York Station between eleven and twelve o'clock on Monday morning. Two fish wagons, which had been detached from a passenger train from Hull, were standing on the up main line awaiting shunting, when the 11.33 empty stop train from Newcastle entered the station from the north end, and dashed into them. The engine struck the wagons with great force, sending the rear vehicle spinning round, and then carrying it fixed on the front of the engine nearly half the length of the station before the train could be brought to a standstill. The other truck was thrown on the up line platform. Neither the engine nor the trucks received serious damage, and beyond a bent rail there was no injury to the permanent way.

NOTES AND MEMORANDA.

GOLD quartz of extraordinary richness is said to have been found in Harpanhally, Bellary district, India.

IT is reported from Tomsk, in Russia, that a rich gold reef, 7ft. wide, has been discovered in the forest on the river Berikule.

THE Chenab Canal, the largest canal in India, has a bed width of 250ft., 11ft. depth, and carries 11,000 cubic feet per second, while the largest canal in Egypt has a width of 195ft. and depth of 32ft.

ACCORDING to a Reuter's telegram, a cloudburst occurred over the village of Zenot, near Knajazevas, in Servia, on June 21st. Fifty-four houses were swept away, and thirty-eight persons perished.

DURING Sunday night the temperature at Dover was the lowest recorded in June for over half a century, being only 40 deg., with thick white frost on the ground. The cold was succeeded by a hot day.

THE consulting engineer to the City of Boston, Massachusetts, says in a report recently issued on the feasibility of damming the Charles River, that Boston is sinking steadily into the sea at the rate of 1ft. a century.

THE Arsenal officials are said to have arrived at the conclusion that during the recent explosion seven 9·2in. shells exploded, representing 322 lb. of lyddite and 3171 lb. of steel forming the shells. Pieces of the latter were picked up as far as half a mile from the danger buildings.

TWO earthquake shocks were experienced in Bangor on Friday morning last. The shocks were slight, but caused considerable alarm. No damage is reported. At the infirmary patients were removed from the wards into the grounds. An earthquake shock was also felt in Holyhead and district about ten o'clock on the same morning, attended by a rumbling noise.

SOME 1500 tons of rolled steel, made by the acid and open-hearth processes, will be used for building the Victoria Falls Bridge, which will be of 500ft. span crossing the Zambesi, some 400ft. above the water level. The work will be started early next year, by which time the railway from Bulawayo to the Falls, a distance of 278 miles, of which 167 miles of line have already been laid down, is expected to have been completed.

THE production of sulphate of ammonia in Canada has grown in recent years with the introduction of the by-product coke ovens in Nova Scotia. At Sydney the Dominion Iron and Steel Company has extensive works; in Quebec, Ottawa, and Toronto the ammoniacal liquors from the gas works are treated by the Michigan Ammonia Company, and in Montreal a concern manufactures sulphate of ammonia for its own use.

ABOUT 247,000 tons of steel fly away in dust from the railroads of the world yearly, according to tables submitted to the mining and smelting section of the International Chemical Congress now in session, by Dr. A. Haarman, of Osnabruck. Of this amount 19,000 tons is lost through friction in the German railroads alone. The experience of Europe, it was also announced, had now demonstrated that iron sleepers are as cheap as wooden sleepers.

THE production of Portland cement in the United States for 1902 was 16,875,506 barrels, according to an estimate prepared by the Division of Mining and Mineral Resources of the United States Geological Survey. The natural cement production was 9,083,759 barrels, and of slag cement 478,555 barrels. The total gain in production over 1901 is more than 30 per cent. In 1892 only 547,440 barrels of Portland, as against 8,211,181 of natural cement, were produced.

OF the 79,742 houses in Paris, 47,716 may be regarded, says *Le Journal* of Paris, as very good, or good from a hygienic standpoint, and 32,026 as indifferent or defective. Out of the above total 59,959 are provided with spring water, and 11,050 with both spring and river water; while 23,252 have modern sanitary arrangements. Lighting is effected by electricity in 4651, by gas in 57,740, and by oil or petroleum in 17,351. The number of Paris houses provided with lifts is 2224.

IN his report for 1902, Mr. W. H. Pickering, Inspector of Mines, says that the expansion of the Yorkshire coal industry continues to be remarkable. In spite of several deplorable disputes between owners and miners, the increase in the output amounts to over a million tons, and nearly 2500 more persons are employed. During the year two important sinkings which attack virgin coal areas have been commenced. Other new ventures are projected, and the older mines are in many cases being refitted with superior machinery.

ACCORDING to a correspondent of the *Standard*, the annual rainfall on the Khasia Hills, to the North-East of Calcutta, amounts to some 600in., 500in. of which fall in seven months, during the south-west Monsoon. It is undoubtedly the wettest spot on the globe. As many as 150in. have been registered in five consecutive days, or an average of 30in. a day. This astonishing amount is due to the abruptness of the mountains which face the Bay of Bengal, from which they are separated by 200 miles of low swamps and marshes.

THE number of separate fatal accidents in coal mines which took place in 1902 in the Yorkshire and Lincolnshire district is the highest on record, though, owing to the increase in the number employed, the death-rate is only slightly in excess of that of 1901. During 1902, 110 separate fatal accidents occurred, involving a loss of 114 lives, an increase of three and four respectively. The general death-rate is 1·06 per 1000; for boys under sixteen it is 1·35 per 1000, showing that boys run a greater risk in mining work than the men.

THE Allgemeine Elektricitäts Gesellschaft is, says the *Electrician*, putting on the market an electric tachometer, consisting of a small generator connected to a voltmeter. For speeds above 600 revolutions per minute the small generator is directly connected by means of a flexible coupling to the shaft, the speed of which is to be measured. For speeds below 600 revolutions per minute the machine is geared up through a spur-wheel gearing or a belt. The voltmeter may be fixed at any distance from the generator, and several may be connected to the same machine.

A CONSULAR report says that in two places on the sea near Sorrento the smell of petroleum is distinctly noticeable to those in a boat passing the localities. This is attributed to an under-water spring of this oil. At a spot 15 miles away, and on shore, a petroleum spring used to exist, but it has not been mentioned since 1679. The depth of water at the point where the smell is noticed is 80 fathoms, or too deep to permit of the collection of the oil being commercially possible. It is suggested, however, that deep borings on land might yield a profitable supply of petroleum.

THE twentieth report has just been issued, as a parliamentary paper, of the Comptroller-General of Patents, Designs, and Trade Marks, for the year 1902. The receipts from patent fees during the period under review were £218,371, as compared with £210,187 in 1901, being an increase of £8184; from designs fees £3566, as compared with £3432, an increase of £134; and from trade-mark fees £11,984, as compared with £10,506, an increase of £1478. The sums received from payment of renewal fees, in each year, since the date when the present scale came into force, have increased gradually from £88,856 in 1891, to £137,945 in 1902.

MISCELLANEA.

THE extension of Cawnpore municipal water supply and drainage to the Cantonment is contemplated.

RUSSIA'S diplomatic representative at Seoul is engaged in trying to obtain from Corea the duty-free importation into Corea of machinery and material required by the large factories on the Yalu River and at Ulengdo.

THE King has approved the formation of a corps of Volunteer Engineers to be designated the 2nd Lanarkshire Royal Engineers—Volunteers—with headquarters at Coatbridge, and having an establishment of nine fortress companies.

A SHIP'S pump has, it is said, been invented by Mr. G. Foster Howell, editor of the *American Shipbuilder*, and the only cost of its operation is the lubricant required. It consists of a normally horizontal lever with a vertical pump rod at each end, and a weighted pendulum at the centre. The roll of the ship swings the pendulum and drives the pump rods.

NIAGARA FALLS has, says the *Iron Age*, had its share of labour troubles, and as it is a growing industrial centre it is interesting to mention that the manufacturers have banded together in an association for mutual protection from employés and others who seek to accomplish a lawful purpose by unlawful means. The organisation has been named the Employers' Association of Niagara Falls, N.Y.

IN view of the great increase in the number of warships which form Russia's Pacific squadron, the Ministry of Marine has decided to establish several dry docks in the Far East. A dry dock is nearly ready for use at Port Arthur. A naval architect left Cronstadt recently for the Far East, where he will make a round of inspection of the existing docks with a view to taking such measures as will make them capable of being used by Russian warships.

THE German gunboat Eber, recently launched at Stettin, has a length of 203·4ft.; beam, 31·8ft.; draught, 10·17ft.; displacement, 980 tons; engines, 1300 horse-power; speed, 13½ knots. She is fitted with Schulz-Thornycroft water-tube boilers. Her armament consists of two 4·13in., eight 1·45in., and six machine guns. Her bunkers have room for 240 tons of coal against the 190 tons carried by the Iltis class, but like this class her complement is 125 men.

THE largest iron ore cargo ever carried in America was taken from Duluth by the steel ship I. L. Elwood, of the Pittsburg Steamship Company, early in June. It consisted of 8579 tons and was taken on 18·5ft. draught. The Elwood is one of four ships built for the American Steel and Wire Company, and is 498ft. long. The four are duplicates, and are the largest vessels afloat on the Lakes, but are to be beaten by a ship exactly 500ft. long that is to be constructed on the St. Clair River.

THE quantity of coal imported into France in the first three months of this year was 2,743,950 tons, as compared with 2,736,960 tons in the corresponding quarter of 1902, and 3,038,240 tons in the corresponding quarter of 1901. British coal figures in these totals for 1,499 500 tons, 1,586,430 tons, and 1,882,880 tons respectively; Belgian coal, for 876,400 tons, 924,740 tons, and 981,360 tons respectively; and German coal, for 293,240 tons, 181,270 tons, and 157,720 tons respectively.

A PARLIAMENTARY paper was issued on Monday night containing a report on changes in the rates of wages in the United Kingdom in 1902. It stated that last year, as in the preceding year, the net result of all the changes recorded was a decrease. In all 890,356 workpeople had their wages changed, the net effect of all the changes being a decrease in weekly wages of £72,700. This result was due almost entirely to the fall in coal miners' wages, which commencing in 1901, continued practically throughout last year.

THE new Service rifle is, says the *Army and Navy Gazette*, a composite weapon avoiding all the alleged demerits of the Lee-Enfield and embodying all the advantages. It will be more portable than the old; the long barrel has been shortened to adapt it for cavalry use; it has been given a twist to ensure sufficient range, the mouth of the barrel has been widened to do away with excessive "kick." The sighting is said to be an improvement, and the plan of the magazine will allow of the loading from a clip of ten cartridges.

WATER waste has reached such a serious stage in Chicago that the Chief of Police has issued orders for the arrest of all persons found violating the ordinance which restricts lawn sprinkling to a couple of hours early in the morning and four in the evening. The loss of pressure in apartment houses in some parts of the city is causing much inconvenience. The city engineer is blamed for much of the trouble, and he admits that the situation is serious. In his opinion the remedy to be applied first is to check the waste, in which view he deserves the approval of all.

THE Lothian Miners' Federation held its annual demonstration on Friday last, 3000 men taking part. A resolution was adopted protesting against Parliament rejecting the Mines' Regulation Amendment Bill and pleading for support for the better representation of labour in Parliament. Resolutions were also adopted condemning the coal tax, and demanding the extension of the Compensation Act. In view of the Taff Vale decision, a motion was carried calling upon the Government to pass a measure giving workmen through the Unions equal rights with capitalists to deal with trade matters.

FIRST-CLASS torpedo-boat No. 113 satisfactorily passed her final official full-speed trial at the Maplin Sands on Wednesday of last week. This is the last of five similar boats built by Messrs. John I. Thornycroft and Co., Limited, of Chiswick. These boats are 166ft. long by 17¼ft. beam, and are slightly larger than the four vessels built by the company two years ago. The armament consists of two torpedo tubes, one forward and one aft, and the three 3-pounder guns are similarly disposed. The speed of No. 113 on her final trial was 25·122 knots. The maximum results for three hours obtained with these boats were:—Speed, 25·426; revolutions, 393; horse-power, 3069.

AT the present moment the German navy does not possess a submarine boat, and, so far as is known to the general public, no boat of that type is in course of construction. The shipbuilding firms of Germany have, however, been engaged for some time in attempts to discover some type of submarine that would be used almost exclusively for coastline defence. So soon as anything definite is arrived at it is expected that the German Government will give the shipbuilders some encouragement. Hitherto naval circles in Germany have not been at all in favour of submarines being used in their navy; however, there are now signs that there has come about a change of opinion in the matter.

THE Committee which was appointed in 1900 to consider the question of berthing accommodation for the Navy, in their final report, dated January last, but only just issued, state that supposing recommendations which they have previously made and now suggested are approved, and allowing for the proportion of ships likely to be absent on foreign stations, there would still remain a serious deficiency of accommodation for long battleships and cruisers. It appeared to them that the growth of the Navy will shortly make it impossible for the existing dockyards to accommodate all the ships, and the time had come for the country to consider seriously whether the formation of another naval establishment was not necessary. This recommendation has evidently resulted in the Government's decision as to St. Margaret's Hope.

NIAGARA FALLS—POWER HOUSE, No. 2

(*For description see page 646*)

EXTERIOR WALL OF FOREBAY STRUCTURE

INTERIOR OF FOREBAY BEFORE THE HOUSING WAS BUILT

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. C. (Liverpool).—The Campania was launched on September 8th, 1892.

J. W. B. (Liverpool).—Your best course would be to write to Brunner, Mond and Co., Winnington, Northwich.

J. W. H.—We do not illustrate untried inventions. You do not say whether your hook has or has not undergone a practical test.

J. G. (Dublin).—Any metal broker will supply you with soft steel billets. You buy pig iron and steel now from some merchant, we presume; he will supply you—if not, write again.

A. W. R.—There is a book by Claxton Fidler, published by Griffin, which may answer your purpose. You would do well to visit the Patent-office Library and make a selection for yourself.

W. G. (New Brompton).—To reverse gas and oil engines involves such complications that it is rarely, if ever, done. If reversing is necessary, as in motor cars and launches, gear for reversing the shaft is provided.

J. G. (Stamford Hill).—In order to ascertain the numbers of all the patents that have been granted for submarine boats, you will have to make a search at the Patent-office Library, Southampton-buildings, Chancery-lane.

C. J. S. (Maida Vale).—We cannot name anything more likely to suit you than Froude's investigations. See the "Transactions" of the Institution of Naval Architects, which you can consult at the Patent-office Library, Southampton-buildings.

E. B. E. (Brymbo).—We are not at all sure that your invention is novel. The grid valve is certainly very old, and all that you can patent is its application to a new purpose. We do not think it would be easy to prove that a grid valve has never before been used as you propose to use it.

S. G.—You cannot fit an automatic expansion governor to an old beam engine. It is possible that you might find a high-speed Pickering governor better than the old pendulum governor. The parallel motion is out of fashion now, and we can only refer you to old treatises. Consult Bourne on "The Steam Engine," which no doubt you can see at your public library.

G. J. (Shrewsbury).—In the first place, the locomotive superintendent would have to be convinced that the saving in fuel would be effected. To do that, costly experiments, extending over many months, would have to be made. Capital would have to be invested. No demonstration on paper would be of the smallest value, and even in case of success it is very doubtful that the original inventor would receive a reward that would pay him for his time and trouble and money.

INQUIRIES.

CASH CARRIERS.

SIR,—I shall be obliged to any reader who will give me the address of makers of cash carriers for shops.

June 20th. OAMSIDE.

"SAMPSON" TRUCKS.

SIR,—Can any of your readers tell me who are the makers of the "Sampson" trucks, having four ordinary and one centre wheel, to carry 5-ton loads?

June 24th. T.

TUBULAR COKE HEATERS.

SIR,—I should be much obliged if any of your readers could give me the names of any manufacturers of tubular coke heaters for passing dry hot air through a large drying chamber 60ft. long.

June 24th. H. H. L.

MEETING NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-UPON-TYNE ASSOCIATION OF STUDENTS.—Tuesday, June 30th, Visit to the Forth Banks and Close Power Stations of the Newcastle and District Electric Lighting Company. Assemble at the Close Works at 2.30 p.m.

THE ENGINEER.

JUNE 26, 1903.

THE APPRENTICESHIP SYSTEM.

No paper at the recent Conference was followed by a better sustained or more instructive discussion than the excellent monograph on the "Apprenticeship of Engineers," written by Professor Cormack. It is a clear and concise statement of the present position of the practical side of the training for our profession, and, being absolutely free from any bias, it was an ideal contribution on which to centre a general debate. As it is generally understood that the occasion was the last on which this matter will be discussed—at any rate, by the parent societies—before it is brought before a special committee, it may not be without value to collect the various views which have been expressed at this and other meetings, and the opinions that we have been ourselves able to gather from engineers all over the country, and thus to arrive at a fairly accurate notion of the present feeling with regard to apprenticeship systems.

It may, then, be safely asserted that there is almost perfect unanimity on the necessity of a combined training. Few doubt that a college training alone is insufficient to make a complete engineer, and no one doubts that a shop training alone is not enough. There are, of course, differences of opinion as to the respective weights that are to be accorded to each branch—the scientific and the practical—but as we have said, there is cordial agreement on the point that a combination is desirable. The question, therefore, resolves itself into the manner of combining the two parts. There are, we think it may be safely said, but few advocates of a concurrent system. Two or three persons spoke strongly in favour of evening classes; but the feeling of master engineers as a whole is that if a youth does a good day's work in the shops he is not fit for much study at night, and Dr. Kennedy went so far as to declare that evening classes are absolutely injurious. On this point we ourselves are in hearty agreement with him. If a lad starts at six in the morning and does his nine and a-half hours' honest work, he will be too tired physically to give such attention as book work requires without a strain which, to the average youth, is likely to result in more harm than good. If a concurrent system is a necessity, then Mr. Drummond's plan of giving an hour in the morning when the students are fresh has everything to recommend it. In any case, however, whether evening or morning classes are taken, the training can only be preliminary to a fuller education at a technical college for all youths who wish to rise to the top of their profession. It being admitted, then, that college at some time or another is essential, the question to be solved is when to give the college training. All the debates lately have centred ultimately round the scheme revived by Mr. Yarrow, that is, the six month sandwich system. Mr. Yarrow brings to whatever he undertakes untiring energy, great resources, and considerable personal influence; and there seemed at one time to be a danger that his zeal would result in a number of influential persons binding themselves to the support of the plan which he advocated without giving it sufficient thought. Happily, the Conference discussion has shown very positively that that danger does not exist. There is not the slightest doubt that the opinion of the meeting on Thursday was against the thin sandwich, and there is equally but little doubt that it was in favour of the thick sandwich, but with this exception, that whereas Mr. Yarrow's sandwich would be compound, several slices one on top of the other, the weight of opinion was in favour of a single alternation. The favoured system would commence with, at least, one year at the works immediately after leaving school, then two years college, and then back to the works again to complete the practical training. This is the plan—a plan, by the way, that we have recommended for many years—which Professor Cormack has conveniently styled "works-college-works," and it is fairly safe to anticipate that when the committee on the training of engineers comes to sit, it will find the weight of opinion very largely in its favour.

In concluding this brief review we may help to spread a plea that has been made by all the teaching authorities who have had anything to say on this question. Without exception, or shall we say with one exception, because Professor Burstall implied that no change could be made in the Birmingham University training, they expressed their anxiety to meet the wishes of employers, and declared themselves to be ready, as soon as a definite scheme had been formulated, to do their utmost to fall in with it. This is a very admirable spirit, and it will do much, indeed, to establish a cordial understanding between the manufacturer and the professor. Indeed, we can imagine nothing that is more likely to result in good to all parties, to the employers, to the professors, and, most of all, to the students, than the frank discussion of the whole question on a broad basis by the manufacturer and the teaching authorities.

THE VALUE OF RESEARCH.

LAST week we asked what the labours of the Research Committee on Steam Jackets of the Institution of Mechanical Engineers had done for the steam engine. Mr. Davey, as chairman of that Committee, has replied to our question in an interesting letter, which will be found on another page. It is desirable before going further, that we should say here that Mr. Davey seems to have failed to grasp our meaning. We never for a moment intended to convey the idea that the members of the Committee were incompetent or inefficient, or that the inquiry was not adequately carried out. On the contrary, it is certain that no body of men could have been selected more able to deal with the subject or solve the difficulties which it presents. It is true that the Committee worked for a long time without reporting, and this caused some animadversion; but we do not think that the delay could have been avoided. Our question was intended to convey the impression that the inquiry carried out with so much pains, at considerable expense, and by men thoroughly well versed in thermodynamics on the one hand, and in practical steam engineering on the other, had resulted in nothing, and that opinion we must continue to hold until Mr. Davey or some other authority can show that we are wrong.

It is, before all things, in this connection necessary that we should clearly understand what are the points at issue. Research may have two principal

objects. It may be intended to obtain and marshal facts, and from these draw deductions which will be of utility to the engineer, or the chemist, or the steel maker, or the electrician. Or it may have for its object the more or less blind search for what may chance to turn up. It is, of course, beyond question that very valuable discoveries have been made even in this way. For our present purpose, however, we have little concern with any form of research but the first. The Steam Jacket Committee of the Institution of Mechanical Engineers had before them the fact that opinion was divided as to the value of steam jackets; that very anomalous and even contradictory results were obtained in practice from their use; that the steam jacket was intimately mixed up with the condensation of steam in engine cylinders; and several other points of minor importance. The Committee were appointed to investigate the phenomena, and trace the connection between them. There was no hope that "something new would turn up," unless, indeed, it could be shown that the last word remains to be said about thermodynamics. What was lacking was definite information which could be utilised by steam users, or by those employed in the design of engines. To take one question as an example. It is known that some engineers hold that a low-pressure cylinder ought to be jacketed; there are others who maintain that it ought not. Both cannot be right. It was to be hoped that the Research Committee would be able to prove to demonstration which practice was the better. The Committee has done nothing of the kind. In so far its work has been barren of result. Engine builders still jacket all their cylinders, or none of them, or one or two, without any trace of system or uniformity of conviction. We approach the question involved with an open mind. We have no preconceived views. Mr. Davey, as chairman of the Committee, knows all about them—what they have done and have not done—and we ask him now to say whether the inquiry and the publication of the reports of which he speaks has had any effect at all on the methods of construction adopted by different steam engine building firms in this country or abroad. For example, has he, as a result of the labours of the Committee, introduced changes in the jacketing of his own pumping engines? If he has, it would be most interesting and valuable to know precisely what the changes are, and what has been the result of the changes.

Our readers need no persuasion or argument to induce them to accept the view that unless something comes of an inquiry the inquiry has been wasted. In politics it is understood that the appointment of a Committee is a convenient way of getting out of a difficulty. An inquiry often prolonged over many months is carried on. Then a report is drawn up and submitted to Parliament, and nothing at all happens, and no more is heard of it. There is always a danger that the work of research may follow similar lines. We could cite various elaborate Government inquiries as examples. An inquiry is carried out—it may be by an individual, it may be by a Committee—and the information may either be of no practical value, or it may be inapplicable to the conditions of trade or manufacture. Very often the end of the whole matter is the satisfying of curiosity. We are by no means alone in saying that no subject has been more abused than research. This is peculiarly true of the work carried on in various technical colleges. Be this as it may, the value of all research depends not only on the information obtained, but on the way in which that information is used. Thus let us suppose that the Committee on Steam Jackets succeeded in obtaining much useful information. Suppose for a moment that they had reported against the jacket, and said that the weight of evidence went to show that steam engines of all kinds were invariably better without it; if, now, the engine builders and steam users for whose benefit this information was obtained persistently refused to make use of it, and went on building engines with jackets, it is evident that the labours of the Research Committee would be wasted. In other words, it serves no good purpose to carry out inquiries unless the results not only admit of being used with advantage, but are so used. When an inquiry of any kind is planned which involves considerable expense, it seems to be desirable that proof should be given, in the first instance, that the report will be utilised. Let us take, for example, any one of the Committees on Standardisation. They report in favour of certain sections, let us say. Unless all concerned accept these sections, roll them, and specify for them, the report and the inquiry are alike valueless. It comes about in this way that much prudence is required in selecting a subject for investigation, because there are two essentials lacking either of which it is of little or no value. The first is that the inquiry should obtain new information; or, at all events, co-ordinate what is already known, and put it into such a shape that it can be employed as a guide in practice. The other condition is that the information so obtained shall be popular—that is to say, of a kind that will commend itself to engineers, or chemists, or electricians—in fact, to all concerned. If research does not satisfy either or both of these conditions, then it represents waste of time and money.

We must ask our readers to understand clearly that we do not write at all of that class or type of inquiry that gave the world radium, or seeks to supply information about the material of the stars, or the reason why the sun is hot. We are referring solely to what may be called utilitarian inquiries, and particularly those which have to do with engineering problems. The researches of Fairbairn, Barlow, and many others on the strength of beams and girders supply an admirable example of utilitarian research. Unfortunately it is possible to undertake inquiries which lead nowhere and result in no advantage to the profession, although not a little noise is made about them. Many municipal councils seem to revel in these things. It is the easiest thing in the world to undertake an inquiry or carry on a research. It requires a very rare combination of skill and foresight, and, in a word, brains, to work out in the present day any investigation which will add to the information possessed by engineers. The work done by the Standardisation Committees is an instance of good and useful results, and we hope that by the time the Steam Jacket Committee has finished its labours the problem of the jacket will be nearer solution.

METROPOLITAN RAILWAYS.

THE paper read by Mr. S. B. Cotterill on Thursday, the 18th instant, in Section I. of the Engineering Conference was followed by a very instructive discussion. Men who thoroughly understood their subject did not hesitate to express themselves freely. The result was not, perhaps, very encouraging. A striking picture was drawn of the conditions under which the movement of the inhabitants of London and its environs has to be carried on. There is only one good feature about the whole matter. The conditions are so rigorous that they deprive the engineer of all chance of an alternative. He need not weary himself in weighing objections, or balancing advantages. It must be the deep tube in the London clay or nothing. There are three methods of providing railways. There is the high level; the shallow tunnel—virtually a covered-in rectangular subway; and there is the deep tube. It might seem at first sight that there was absolutely nothing to be said in favour of a high-level line, noisy and hideous. But this is not the case. It is freely admitted that a road of this kind must not be constructed in any leading thoroughfare; but why not construct it in back streets, inferior districts of little traffic and comparatively small value? The answer to this argument is at once conclusive and far-reaching. It affects the whole question of urban railway communication, high level, shallow level, deep tube, or surface tramway alike, and it effectively disposes of numerous suggestions made over and over again by amateurs.

This answer was given in very few words by Mr. Galbraith on the 18th inst. The railway must follow the main lines of traffic. Thus a line from Charing Cross to the City must run under the Strand, Fleet-street, and Ludgate-hill. If railways are made in or under back streets the public will not use them. It is waste of time to argue the point. There is the fact, and a terribly expensive fact it is. Under modern arrangements the driving of a tube railway in the London clay some fifty or a hundred feet below the surface has become a very simple matter. Such a tube is not by comparison expensive; its construction does not interfere with the streets; it can hardly be said to infringe any vested interests. But the deep tube is of no value without stations—that is to say, modes of access—and the construction of these stations is the crux of the undertaking. As an instance we may quote a case cited by Mr. Galbraith. It was proposed that the Baker-street and Charing Cross line should have a station on the Embankment, and not in Trafalgar-square. It was pointed out that no one would use the Charing Cross end of the line if he had to walk back from the Embankment to the Strand. It was imperative that a station should be made at Charing Cross, and the cost of a site occupied by two small shops was no less than £80,000. The almost fabulous value of land in London renders the outlay on stations enormous. It is useless to think of placing the stations where the land could be had for a moderate price; and account must be taken of the fact when planning a railway. Nothing would be gained in this way by making the line near the street level. It is the surface, and the surface only, that costs the money. The expense of shafts and lifts is, of course, greater the deeper the line. But none of the speakers during the discussion seemed to attach much importance to this fact.

It has been proposed that even in the older streets subways should be constructed in which to place pipes and wires of all kinds side by side with the railway; and it has even been argued that the cost of the pipe subway should be borne by the railway company. But it was pointed out that, even if room could be found for these things, the population living or carrying on business in, say, Fleet-street, would not stand the breaking up of the whole street for at least a year. That would simply mean ruin, and would bring about a popular tumult. In new streets the subways are constructed; but unless the subway system is continuous and thorough it cannot help the railways. We must accept the conditions as we find them, and two methods, and two only remain to us, namely, the deep-level tube and the surface tramway. But this last cannot be used in the more crowded streets of London. It has its value, but its sphere is suburban, not urban. We cannot have tram lines in the heart of the metropolis. Apart altogether from the considerations and conditions we have named, there are additional reasons for resorting to deep levels. No urban system can be considered complete unless it links the north and the south, as well as the east and the west. This means that lines must pass under the river. Several do this as it is; but it was not disputed by those who discussed Mr. Cotterill's paper that more lines must be made under the bed of the Thames. This renders deep tubes indispensable, for shallow subways imply difficult or impossible gradients.

The tube railway must be worked by electricity. It is noteworthy enough that not a word was said in Section I. about details. More might with advantage have been heard about ventilation, but no one either affirmed or disputed the statement that the air must be changed two and a-half times an hour; yet this appears to us to contemplate an impossibility, so far as fans are concerned, because of the stations. Air locks cannot be fitted. There must be free access to the street. There is only one way in which ventilation in quantity could be obtained except at an enormous outlay, and that consists in fitting every train with a "wooden" head" nearly the same diameter as the tunnel. This, as the train ran, would push air before it, which would escape out of the stations. The difficulty is that when two trains or more were in one section, the air between the two trains would remain between them. Still, something would be gained. In the construction of the stations and lifts there is no doubt room for improvement; yet when all has been done that can be done, the deep tube cannot be regarded as entirely satisfactory. Roads of the kind involve two separate movements, the one vertical in the lifts, the other horizontal. There is a change of vehicle at every station. The ideal mode of locomotion is the tramcar following the main line of traffic. But all the details of metropolitan life are in the main compromises. They are not the best. Some approach nearer than others to that desirable consummation. In a new ideal city things would be better arranged. As it is we must put up with an old-fashioned city and make the best of it. Not a few worthy folk find a gloomy pleasure in pointing out and censuring its defects. It must have a good many redeeming features, however, or it would be less densely populated.

SHEFFIELD AND CHICAGO.

THE pushful Yankee has afforded Sheffield manufacturers considerable amusement this week. A letter, typewritten, has been sent round to a number of our leading manufacturers, inviting them to solve the tariff trouble by transporting themselves and their trades to Chicago Heights. Two of the firms favoured with this offer are Messrs. Joseph Rodgers and Sons, Limited, the well-known cutlery manufacturers, and Messrs. Wheatley Brothers, who are also cutlery manufacturers, of Wheatsheaf Works, Sheffield. The invitation comes from the Chicago Heights Land Association, and it invites Sheffield manufacturers to entertain the question of "removing your factory to, or establishing a branch in, Chicago Heights, to take advantage of the growing American market for your product, and to avoid the heavy duties collected here on importations." Chicago Heights is described as an ideal place for manufacturers. "Already," it is stated, "upwards of fifty varied industries are carried on there, including the making of railway cars, engines, and appliances; of plate glass, cut glass, and bottles; of woollen yarns, iron and steel castings, machinery, iron pipe, steel pipe, tile roofing, fire-proofing, vehicles, stoves, pianos, organs, &c." The letter, which is sent by "M. H. Kilgallen, General Manager," goes on to point out that Chicago Heights contains over 10,000 inhabitants, and all

modern improvements, good schools, churches, public library, electric lighting, and water service." Moreover, it is only 25 miles distant from, and on direct lines of railway to, the coalfields of Illinois and Indiana. As further inducements for Sheffield manufacturers to betake themselves to Chicago Heights, it is pointed out that the Association builds houses for new comers as rapidly as the demand for them arises, and houses are for sale or to be let to factory helps at low figures and on easy terms. As if all these were not sufficient inducements, there are added "free sites for factories, and a free switching or 'shunting' service." So far, no Sheffield manufacturers have entertained the idea of removing their business to the Chicago Heights, and are not likely to do so, but it is curious that this invitation should come at the very moment the country is called upon to consider a revision of its fiscal arrangements owing to pressure of prohibitive tariffs, which pressure is nowhere more severe than in the States.

SIR JOSEPH PEASE.

FEW men have occupied a more prominent position in connection with the iron and coal trades of the North-East of England than Sir Joseph Whitwell Pease, whose death took place on Tuesday evening, at Falmouth, where he was on a visit. He was born at Darlington, in 1828, his father being Mr. Joseph Pease, the son of Edward Pease, who was closely associated with George Stevenson, in the introduction of railways; in fact Edward Pease has often been referred to as the "Father of railways." Sir Joseph received his education partly at the Friends' School, York, and partly with private tutors. At the age of seventeen he had the choice of going to college, or of entering business, and he determined upon the latter, taking a place in his father's office in September, 1845. At the age of twenty-four, he had practically the command of several business enterprises, which had been carried on by his father and grandfather. He not only superintended these, but took a responsible part in the inception of new ventures, chiefly in connection with the coal trade and the extension of the railway system. He was made a director of the Stockton and Darlington Railway in 1853, and after some years he and the late Colonel Stobart conducted the arrangements for the amalgamation of that line with the North-Eastern Railway, which were concluded in 1863. He was elected a director of the North-Eastern Railway Company, and from 1895 to 1902 he was chairman of the company, having previously been deputy-chairman for several years. He was associated with the negotiations for some of the most important developments of this line.

Sir Joseph and his partners were among the largest colliery owners in the country, their pits being in South and West Durham. They also carried on a large trade in limestone, owning a number of quarries in Weardale. They were also among the earliest to commence ironstone mining in Cleveland. When a few years ago the business was turned over to a public limited company the capital was subscribed several times over. Sir Joseph was also a large shareholder in some of the pig iron making firms in the Cleveland district. He was the chairman of "The Owners of the Middlesbrough Estate, Limited," which owned the bulk of the land on which the town of Middlesbrough has been built.

Since 1852 he was a member of the Tees Conservancy Commission as representative of the Admiralty. He was, in fact, the oldest member of that body, and for more than a quarter of a century was the chairman, resigning only this year, when financial troubles overtook his firm.

He was all his life connected with the firm of Robert Stephenson and Co., locomotive engine builders, which was founded in 1822 by Geo. Stephenson and Edward Pease, and for years was the chairman of the directors.

Sir Joseph was the "Father of the House of Commons," having been elected for South Durham in 1867, which division he continued to represent ever since; but he had decided to give up at the next General Election

THE ENGINEERING STANDARDS COMMITTEE.

WE give below a complete list of the Committees and their chairmen who are at work on the standardisation of the various manufactures specified. We think nothing could show more clearly the very wide area that is being covered.

Committee.	*Chairman.*
Main Committee	Mr. James Mansergh
Finance Committee	Mr. James Mansergh
Calculation Committee	Mr. H. J. Cornish
Committee on Ships' Sections ...	Mr. A. Denny
Sub-committee on Ships' Tests	Mr. A. Denny
Committee on Rails	Sir John Wolfe Barry, K.C.B.
Sub-committee on Railway Rails	Mr. J. C. Inglis
Sub-committee on Tramway Rails	Mr. W. Howard-Smith
Sub-committee on Tire Profiles	Mr. James Holden
Committee on Railway Rolling Stock, Underframes	Sir Douglas Fox
Committee on Bridges and Building Construction	Sir Benjamin Baker, K.C.B.
Committee on Locomotives	Sir Douglas Fox
Sub-committee on Component Parts and Types	Mr. F. Wolley-Dod
Sub-committee on Tires, Axles, and Springs	Mr. W. Lorimer
Sub committee on Steel Plates	Mr. W. Lorimer
Sub-committee on Copper and its Alloys	Mr. William Dean
Committee on Electrical Plant ...	Sir William Preece, K.C.B.
Sub-committee on Generators, Motors, and Transformers ...	Colonel Crompton, C.B.
Sub-committee on Cables	Mr. R. Kaye Gray
Sub-committee on Temperatures of Insulating Materials	Dr. Glazebrook, F.R.S.
Sub-committee on Telegraphs and Telephones	Mr. John Gavey
Sub committee on Electric Railways	Mr. A. P. Trotter
Sub-committee on Electric Tramways	Mr. A. P. Trotter
Sub-committee on Central Station Rules	Mr. C. H. Wordingham
Committee on Screw Threads and Limit Gauges	Mr. H. F. Donaldson
Sub-committee on Screw Threads	Mr. H. F. Donaldson
Sub-committee on Limit Gauges	Mr. H. F. Donaldson
Committee on Pipe Flanges	Mr. W. Maw
Committee on Cement	Mr. William Matthews, C.M.G.

THE ROYAL SOCIETY'S CONVERSAZIONE.

ON Friday night last the Royal Society held the second of its annual conversaziones, this being the evening on which ladies were invited. Among a number of distinguished guests were Monsieur and Madame Curie, whose names are well known in connection with radium, the former of whom delivered the same evening, at the Royal Institution, a discourse on this newly-discovered element.

The exhibits were, in large measure, the same as those which we described when we referred to the first conversazione some few weeks ago. There were others, however, and of these we propose briefly to speak, though there were few which possessed engineering interest. Mr. John Warman showed an ingenious reproduction of the hydraulic organ of Archimedes. In this instrument the wind pressure is obtained by means of the weight of a body of water, instead of from weighted bellows. This model is believed to be the nearest approximation to the original which has as yet been arrived at. Then there was the Cooper-Hewitt lamp, which was exhibited by Professor Ernest Wilson. This lamp has been already described in our columns, but we may recall the fact that it is composed of a glass tube filled with mercury vapour, and with a portion of liquid mercury at its lower end. Electrodes are fused into the glass at the top and bottom, and the light obtained by the passage through the mercury of a low-tension direct electric current. It is necessary, in order to start the lamp, to make use of a high-tension discharge. The light emitted is peculiar, in the fact that it is almost entirely without the red rays of ordinary white light, which renders it unsuitable for many purposes, though, it is claimed, of great value for others, especially where it is not necessary to determine true colour values. It would be interesting to know something more of the manufacture of this lamp, as we understand that other workers, when experimenting on the same lines, have failed to obtain the same results by pursuing the methods of the inventors as published. The light appears to be markedly rich in actinic rays, and should therefore be useful in some branches of photography. Among other exhibits of interest was the torsional viscosity meter shown by Professor Tronton. This instrument has been designed to measure the viscosity of materials, and among those which it has dealt with successfully may be mentioned pitch and melted glass. It was curious, seeing that only the morning of the day before the conversazione there should have been the lamentable explosion at Woolwich, that Dr. Silberrad should have shown some common shells intended to illustrate the effects of the incomplete and of the successful detonation of lyddite.

Lastly, it must be mentioned that Sir William Crookes again showed some beautiful experiments, setting forth the properties of the emanations of radium, and again had on view the spinthariscope, by which instrument it is possible to examine, microscope fashion, small particles of radio active substances.

Considering the inclemency of the evening, it was wonderful that Sir William and Lady Huggins had to welcome so many guests.

DOCKYARD NOTES.

THE cruiser Melampus has been selected to act as drill ship for Naval Reserves at Kingstown, Dublin Bay, in place of the old wooden hulk formerly employed for that purpose.

ON July 7th, just about the time of the Franco-American visit to Spithead, though not on account of this *entente cordiale*, a "revolution in naval warfare" will be before the ship knackers at Portsmouth. On that day the torpedo ram Polyphemus will be sold by auction. To this day it is a mystery to many naval men why this ship failed. In her day she was fast, and her officers had, or professed to have, full confidence in her, yet she was always a "failure." Perhaps it was because war to test her metal was lacking. In the days when the 6in. quick-firer was unknown, the Polyphemus in the smoke of battle—and battles would have been exceedingly smoky in those days—could certainly have closed with hostile ships. To be sure her snout would have ensured that if she rammed a ship she would have gone down with her victim, but she had so many torpedo tubes that ramming would have been superfluous.

IN a way the Polyphemus was a "submersible." Only she was of reasonable size, able to see things, big enough to stand an odd hit or two. "Failure" she was, however, just as the United States ram Katahdin is a failure, and perhaps for the same reason. That reason is that the Polyphemus could do nothing that an ordinary big ship could not accomplish, and usually accomplish better because of larger size. We are gradually learning that to build specially a small vessel to carry what a large one can include may not be sound "business," no matter how nice the smaller craft may look on paper. Consequently several "special service craft" have gone the way of the dodo, though there is perhaps room for plenty of improvement yet. Colonel Cuniberti, with his 22-knot battleship the Vittorio Emanuele, is almost the only man who can be said to have grasped the point thoroughly.

ON Monday last sail drill, that has been a feature of the training ship St. Vincent, was given up. At last it has occurred to the authorities that our battleships are really never likely to sail into action, and, inspired by this great discovery, the sails have gone. In quite dramatic fashion, after a drill with them on Monday, the sails were hauled down off the yards, which are now left bare—possibly with a view to putting temptation out of reach.

THE Victorious from the Mediterranean is due home at the end of this week. She is bringing with her torpedo boats 104, 105, and 106. The Victorious is to pay off at Chatham, and, after refit, will join either the Channel or home fleet—the latter as likely as not.

THE old Devastation, which is practically on the non-effective list, is going to take part in the forthcoming naval manœuvres. This, however, does not mean that she will be chasing Drakes and such like, after the fashion of the Sultan not very long ago. Instead she is to serve as a depôt ship for destroyers—a *rôle* for which these old ships are very well fitted.

THE Belleisle is nearly ready for the next experiments, which will take place in Portsmouth Harbour. Part of her bottom has been fitted to represent a ship's double bottom, and the trial next month will consist in firing a torpedo at this. Warships are, or originally were, given double bottoms to render torpedoes harmless. Many years ago the hulk Resistance was treated as the Belleisle is to be—to see whether a double bottom was any good. It was not found so. However, years have passed since then, so the experiment is to be repeated. If the experiments are carefully conducted we think there is a fair prospect of a considerable amount of data of a quite useless order being gained. An imitation double bottom is not a ship's bottom any more than a slab of armour on the proving ground is a ship's side. These experiments are doubtless interesting to some of those engaged, but till the Admiralty has the courage to try them on a modern ship nothing of any real value is likely to be learned. There are one or two more or less worn-out ships of the Majestic class—of which the Londons are practically copies—one of which might well be selected—the Magnificent, for example.

THE Navy League's Midsummer-day excursion to Portsmouth was a decided success. Special facilities were afforded to the League, whose members saw a good deal that is rarely seen by the visitor.

BY the way, we appear to have made a mistake in associating the Executive Committee of the Navy League with Mr. Arnold White's action over the gunnery question. We have been given to understand that our impression that Mr. White is the spokesman of the League in this matter is altogether incorrect.

BOOKS RECEIVED.

Electric and Magnetic Circuits. By Ellis H. Crapper, M.I.E.E. London: Edward Arnold. Price 10s. 6d.

Submarine Navigation, Past and Present. By Alan H. Burgoyne, F.R.G.S. Illustrated. London: Grant Richards. 1903. Two volumes. 31s. 6d. net.

Technical Arithmetic and Geometry for use in Technical Institutes Modern Schools, and Workshops. By C. T. Millis, M.I.M.E. London: Methuen and Co. 1903. Price 3s. 6d.

The Great Eastern Railway Company's Tourist's Guide to the Continent Edited by Percy Lindley. Illustrated and with maps. Continental Department, Liverpool-street Station, London, E.C.

RÖNTGEN SOCIETY.—The annual general meeting of the Röntgen Society will be held on Thursday, July 2nd, 1903, at 20, Hanover-square. The chair will be taken at 8 30 p.m.

THE JUNIOR INSTITUTION OF ENGINEERS. — There will be a visit of this Institution on Monday evening, June 29th, at 6.30 p.m., to Messrs. John Bennett, Lawes and Co.'s Atlas Works, West Ferry-road, Millwall, by kind permission of the directors.

PUBLIC WORKS IN FRANCE.—According to the *Times* correspondent, a scheme of considerable magnitude, involving an expenditure of 256,000,000f., was voted on the 23rd inst. by the Senate. The urgency of the measure having been recognised, it was passed in a very few sittings, all amendments being rejected. Its object is the improvement of some ten French ports and the construction of new and the deepening of existing canals in connection therewith. The sum of 29,000,000f. is to be spent on improving the navigability of the Garonne, the Orleans Canal, and a series of waterways in the north and south of France. New canals are to be constructed at a cost of 150,000,000f. They include the Canal du Nord, destined to cut off a bend of the Oise and supplement the Saint Quentin and Oureq Canals, the Loire Canal, and other watercourses intended to link Combleux to Orleans, and Cette and Marseilles with the Rhone. The remainder of the credit will be devoted to improving the harbour accommodation at Dunkirk, where it is proposed to spend 26,000,000f., Boulogne, Dieppe, Havre, Rouen, Saint Nazaire, Nantes, where the expenditure will be 22,000,000f., Bordeaux, Bayonne, and Cette. In his statement in the Senate the Minister of Public Works said he did not anticipate that the programme set forth in the Bill would necessitate a loan. The works would be completed in seven or eight years.

THE INSTITUTION OF MINING ENGINEERS.—The thirty-eighth general meeting of the members of the Institution of Mining Engineers will be held in London, on Thursday, July 2nd, and Friday, July 3rd, at 10.30 a.m., in the rooms of the Geological Society, Burlington House, Piccadilly, London, W. On Thursday, July 2nd, 1903, at 11 a.m. the following papers will be read, or taken as read:—(1) "Luxemburg and its Iron Ore Deposits," by Mr. J. Walter Pearse. (2) "The Lake Superior Iron Ore Region," by Professor Van Hise. (3) "Mineral Resources of the State of Rio Grande do Sul, Brazil," by Mr. H. Kilburn Scott. (4) "Electric Coal Cutting," by Mr. W. E. Walker. (5) "Pneumatic and Electric Locomotives in and about Coal Mines," Mr. A. S. E. Ackermann. (6) "Electrical Plant Failures, their Origin and Prevention," by Mr. A. C. Cormack. (7) "The Electrical Driving and Winding-gears," by Mr. F. Hird. (8) "Electric-power Distribution by Continuous Current for Mining and General Purposes in North Wales," by Mr. T. P. Osbourne Yale. The following papers will be open for discussion:—"Lead and Zinc Deposits of the Mississippi Valley, U.S.A.," by Professor C. R. Van Hise and Mr. H. Foster Bain. "The Coalfield of Northern Belgium," by Mr. Emile Harzé. "The Marl Slate and Yellow Sands of Northumberland and Durham," by Professor G. A. Lebour. "The Alston Mines," by the Rev. W. Nall. "Mine Surveying Instruments," by Mr. Dunbar D. Scott. "Sinking by Freezing," by Mr. A. Gobert. "Working Coal under the River Hunter, the Pacific Ocean and its Tidal Waters, near Newcastle, New South Wales," by Mr. A. A. Atkinson, H.M. Inspector of Mines. "Undersea Coal of the Northumberland Coast," by Mr. T. E. Foster. "Electric Traction on Roads and Mineral Railways," by Mr. W. R. Cooper. "Steam Generation by the Gases from Beehive Coke Ovens," by Mr. M. R. Kirby. At 7 p.m. dinner in the Gordon Room, at the Holborn Restaurant, tickets 5s. each, exclusive of wine. On Friday, July 3rd, 1903, the meeting will begin at 10.30 a.m. when the following papers will be read, or taken as read:—(9) "Further Remarks on the Portuguese Manica Goldfield," by Mr. A. R. Sawyer. (10) "Coalfields of the Faröe Islands," by Mr. G. A. Greener. (11) "Miners' Anæmia or Ankylostomiasis," by Dr. J. S. Haldane. (12) "Water-softening Plant," by Mr. Vincent Corbett. (13) "The Re-development of the Slate Trade in Ireland," by Mr. G. H. Kinahan, M.R.I.A., District Surveyor (retired), Geological Survey of Ireland. (14) "The Smelters of British Columbia," by Mr. W. D. Verschoyle. (15) "The Common-sense Doctrine of Furnace Draught," by Mr. H. W. Halbaum. (16) "The Ventilation of Deep Mines," by Mr. Arthur C. Murray, and the following papers will be open for discussion:—"The Tarkwa Gold-field, West Africa," by Mr. A. R. Sawyer. "Notes on the Gold Coast of West Africa," by Mr. Louis P. Bowler. "Treatment of Low-grade Copper Ores in Australia," by Mr. J. J. Muir. "The Fernie Explosion," by Mr. William Blakemore. "Corliss-engined Fan at Seghill Colliery," by Mr. C. C. Leach. "Boring in Japan," by Mr. F. J. Norman. "Gold Dredging in Otago, New Zealand," by Mr. F. W. Payne. "Underground Stables," by Mr. W. C. Blackett. "Improved Railway-rail Fastener," by Mr. J. P. Kirkup. On this day there will be an excursion to City-road Station of the County of London and Brush Provincial Electric Lighting Company, Limited. On Saturday, July 4th, there will be two excursions, one to the Central Power Station of the London United Electric Tramways, 88, High-road, Chiswick, and the other to the National Physical Laboratory.

THE ROYAL SHOW.

THE sixty-fourth annual exhibition of the Royal Agricultural Society, and the first which it has held in its permanent showyard, Park Royal, was opened on Tuesday last, and closes to-morrow, Saturday. The new site is admirably adapted for the purpose to which it has been applied. It is an almost square plot, measuring 116 acres, the freehold of which has been purchased at a cost of £30,000. Originally forming part of the Twyford Abbey Estate, and situated between Willesden and Ealing, the showground could scarcely have been more favourably situated for access from the metropolis. It is six miles from the Marble Arch, and may be reached by three roads, *viâ* Willesden, Acton, or Hanger-lane, while three railway systems, the Great Western, North-Western, and the District, are in close proximity, and have erected new stations to cope with the crowds which are always to be expected. The area of the showyard being greater than has usually been available, the Council have been able to diverge considerably from the arrangements made for former shows, and some new features will be observed, although the buildings in the main are those which have already done good service in all parts of the country. This is, however, only temporary, for we understand from Sir Ernest Clark that the Society intends, as finances become available, to replace these structures by permanent buildings. Since the Society obtained possession of the land the whole has been enclosed by a corrugated iron fence, the cost of which alone was £2000. Then succeeded the work of levelling, draining, sewering, road-making and water supply before the erection of buildings could be proceeded with. The east entrance is a new and permanent brick building, and opposite to this the London and North-Western Railway intends to erect a showground station. Approaching the yard by the Great Western route to Park Royal station the extensive sidings which this company has provided are seen on the right, and the western entrances to the showyard are within 300 yards of the station. As soon as the turnstiles are passed a good view of the showground presents itself, the pavilions and large ring, with its two grand stands, being immediately in front; the horse stables on the left and the implement yard on the right. Beyond the large ring are the sheds for the other live stock, the dairy, and a new feature, consisting in a pavilion, for the Agricultural Education Exhibition, organised by the Society in co-operation with the various agricultural teaching and research institutions. The Board of Agriculture, with commendable promptitude, have also provided themselves with a permanent brick building, whence the interests of the farmer will no doubt be studied "on the spot."

The show of live stock is well up to the average, but falls short of the entries at the record Manchester show in 1897. The implement department shows a considerable growth over the last two shows, but, again, a falling off compared with some of the more successful exhibitions, as will be seen from the accompanying table:—

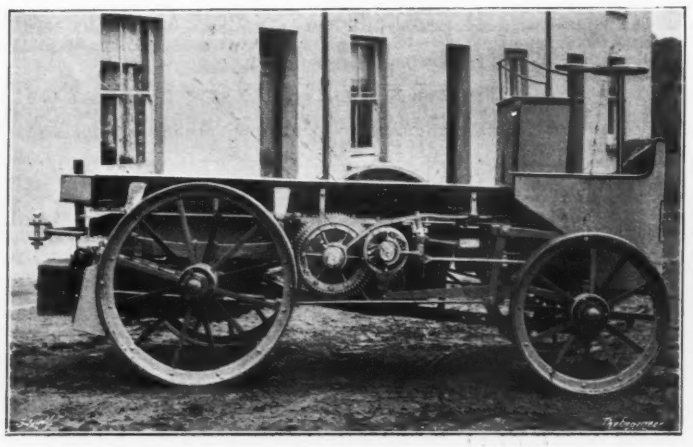
Shedding in Implement Yard (in Feet).

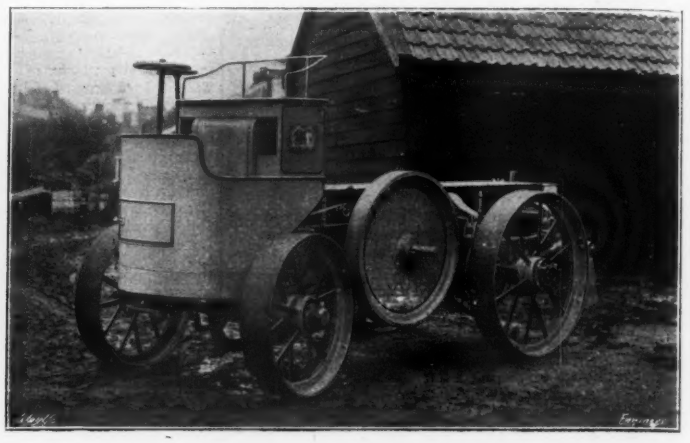
Description of shedding.	London, 1903.	Carlisle, 1902.	Cardiff, 1901.	York, 1900.	Maidstone, 1899.	Birmingham, 1898.	Manchester, 1897.	Leicester, 1896.	Darlington, 1895.
Ordinary	Feet 9,360	Feet. 6,693	Feet. 7,245	Feet. 9,454	Feet 7,455	Feet. 9,350	Feet. 9,320	Feet. 8,506	Feet. 7,528
Machinery	2,670	2,079	2,305	2,547	2,192	3,239	3,334	2,732	2,718
Special (seeds, models, &c.)	2,555	2,321	2,101	2,771	2,553	2,902	2,878	2,692	2,351
Total (exclusive of open ground space) ..	14,585	11,093	11,651	14,772	12,200	15,491	15,532	13,930	12,597
Number of stands	456	340	358	412	395	502	489	450	393

In addition to the extended trials of wind pumping engines in March and April last, which have been fully described in THE ENGINEER for May 1st, and for which prizes of £50 and £20 were respectively awarded to the Goold, Shapley and Muir Co., Limited, of Brantford, Ontario, and to Messrs. Thomas and Son, of Worcester; there were also 95 entries of "new implements" in the catalogue for the Society's silver medals. It may be stated that many of these can be termed new in the sense that they have been recently manufactured, rather than denoting any particular novelty of design. This cannot be the meaning which the Society originally attached to the term "new implement," and it would seem advisable that a more drastic procedure should be adopted to prevent the entry of appliances which have little or no pretension to novelty.

It is our sincere hope that the present show will prove a financial success to the Royal Agricultural Society, whose funds have become somewhat depleted. It is true that the show at Carlisle last year resulted in a heavy loss, but it is the opinion of a large body of implement builders that the new departure of a permanent showyard in the neighbourhood of London will not tend to improve the prospects of the exhibitors, in whose welfare we take a particular interest. We trust that the exhibitors in this section will experience an agreeable surprise. This year the Society has been particularly unfortunate in having to contend against superlatively bad meteorological conditions at a time when fine weather would have been desirable, and the difficulties which the exhibitors of implements have had to overcome in getting their machines into position is evident from the deplorable condition into which the implement yard has been ploughed up. To enable the exhibitors to surmount the possibility of such adverse conditions in the future, it would seem advisable to lay down better roads throughout this section of the yard. Much has already been done in this direction by constructing main roads through the grounds, a precaution rendered necessary by the clayey nature of the land.

The opening days of the fixture were favoured by fine weather, and with the frequent attendance of the Prince of Wales, who is president this year, and the patronage of the King; the same weather conditions only require to continue to make the public attendances satisfactory. The usual formation of the implement yard has had to undergo some change to fit in with the new conditions; although this may be a change for the better, it causes some confusion to those who have for many years been accustomed to the older plans.





Figs. 1 and 2—PETTER'S AGRICULTURAL TRACTOR

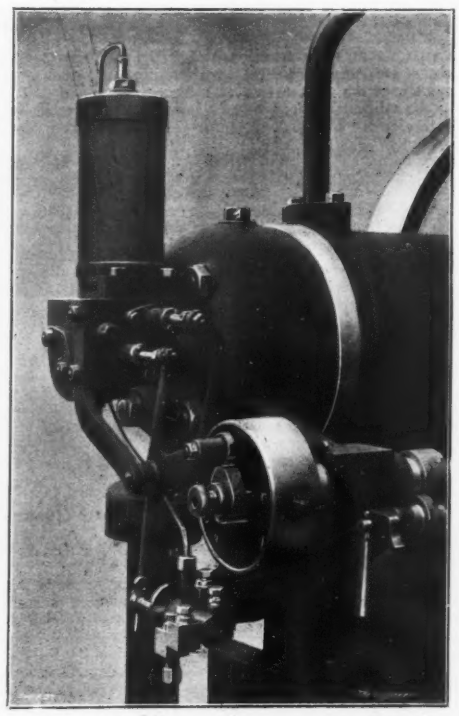


FIG. 3—BLACKSTONE'S NEW VAPORISER

The first impressions derived from a glance round the implement yard will convince the visitor that steam engines, as a source of power, are meeting with a more severe competition than hitherto from internal combustion motors; while the unusually fine display of wind engines which the competition above alluded to has brought together is evidence of the advance which makers of this form of motor have made in recent years. We are pleased to note that builders of self-propelled vehicles suitable for the agricultural industry, and coming within the scope of the Light Locomotives Act, are represented in far greater numbers than at previous shows.

The brief space of time between the opening of the show on Tuesday and the publication of THE ENGINEER will only allow of a somewhat curtailed report this week, but we hope to describe more fully further interesting exhibits in our next issue. One of the most attractive displays of steam engines of the locomotive, portable and fixed types, is that of Messrs. Robey and Co., Limited, Lincoln, the high finish of whose work is well known. This firm has a beautifully finished model of a 200-kilowatt steam alternator, with exciter made to one-quarter scale, so as to be able to work with compressed air as the motive fluid. The finish of this engine is equalled by that of the full-sized long-stroke horizontal fixed engine, fitted with triple-expansion gear. Internal combustion engines are represented by the Robey-Saurer oil engine, which is shown coupled direct to a dynamo, forming a compact arrangement. The governing of this engine is so effectively performed that the engine readily adapts itself to wide variations of load, rendering the necessity of accumulators unnecessary. Messrs. Marshall, Sons, and Co., Limited, Gainsborough, do not exhibit amongst the machinery in motion this year, but the stand loses nothing in attractiveness to the engineer on that account. There are high-speed vertical engines, horizontal, portable, and traction engines. Prominent amongst the exhibits is a self-contained engine of the vertical type, fitted with Pickering's sensitive governor and equilibrium throttle valve. This engine has a cylinder 9in. diameter and 12in. stroke, and is specially adapted for driving quick-running machinery, &c., and for work where perfectly steady running is absolutely necessary, such as electric lighting. They also show one of their new pattern, high-speed, open-fronted vertical engines of the piston valve type, suitable for direct coupling to a dynamo or fan. Both these engines are of high-class construction throughout, and work with steam at 100 lb. pressure. In horizontal engines they exhibit a high-class long-stroke engine with cylinder 12in. diameter and 30in. stroke, fitted with Marshall's well-known trip gear, and having double-beat drop valves both to the steam and to the exhaust. This engine is suitable for 100 lb. steam pressure. The other horizontal engine is of the compound type, self-contained, and mounted on steel girder framing, and suitable for 140 lb. pressure.

Messrs. Ruston, Proctor and Co., Limited, Lincoln in addition to a representative exhibit of steam portable and traction engines and oil engines, show a new implement in a combined independent chopping and bruising apparatus with sifter for reducing straw into fodder suitable for cattle. It is designed to work in connection with a thrashing machine, and it will treat the straw as fast as the thrasher can deliver it. When so operated the straw leaving the shakers falls on the top or chopping barrel, which is fitted with a series of steel knives and rotates at a high speed, carrying the straw round, and in contact with corresponding knives in a fixed concave plate. By this process the straw is cut up into short lengths and passes downward to the second or bruising barrel, which is armed with numerous pegs, carrying the straw forward and beating it up against a series of stationary pegs, arranged in transverse rows, thereby bruising and softening it. The chopping and bruising apparatus is mounted on a sifting riddle, provided with a blower underneath for sifting and cleaning the bruised straw and intercepting and collecting any grains which

may have escaped the shaking apparatus of the thrashing machine during thrashing. The machine is self-feeding, requiring little or no attention, and can be readily attached to any ordinary thrashing machine, which merely needs a lengthened drum shaft and two pulleys to drive the bruising and chopping apparatus, and one extra pulley on shaker crank shaft to drive the sifting part of the machine.

Messrs. James B. Petter and Sons, Limited, of Yeovil, exhibit for the first time the agricultural motor or tractor —shown in Figs. 1 and 2 on page 654. Although of substantial construction this machine has been built to comply with the Light Locomotives Act. It is propelled by the firm's standard pattern horizontal 12 brake horse-power oil engine, which is operated by the gasification and ignition of ordinary paraffin oil. The cylinder is 16¾in. diameter by 15in. stroke, and is fitted with a water jacket, the circulating water being cooled by passing through a radiator. The vehicle may be propelled at two speeds—2½ and 5 miles per hour. With this object the crank shaft carries a sleeve on which are secured three gear wheels for the high and low speeds and reversing. These mesh with corresponding phosphor bronze gear wheels sliding on three feathers on a countershaft. From the latter the power is transmitted by single Renolds roller chain to a wheel surrounding the differential gear on the live back axle. This axle is solid throughout and has one road wheel fixed directly on the shaft, while the other is secured to a sleeve. By this means the division of the axle is obviated. The engine has tube ignition, but requires no lamp after it has been started. The body is mounted on springs, which take up the shocks caused by the road wheels passing over uneven surfaces. The wheels have ample width of tires. This machine is intended to be used for drawing ploughs, cultivators, mowers, reapers, and other machinery. It is also sufficiently powerful to drive a thrashing machine, and it is provided with an easily removable platform, which can be loaded with goods to the extent of about two tons, and in addition, an ordinary farm wagon can be drawn behind.

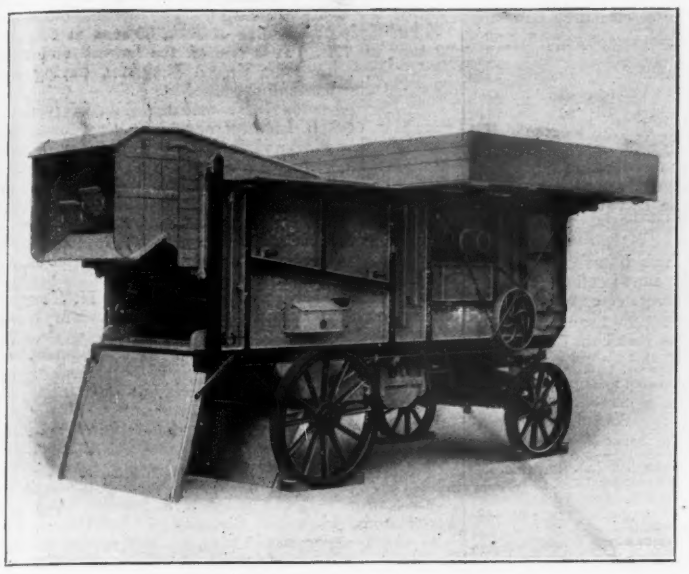


Fig. 4—FOSTER'S COLONIAL THRASHING MACHINE

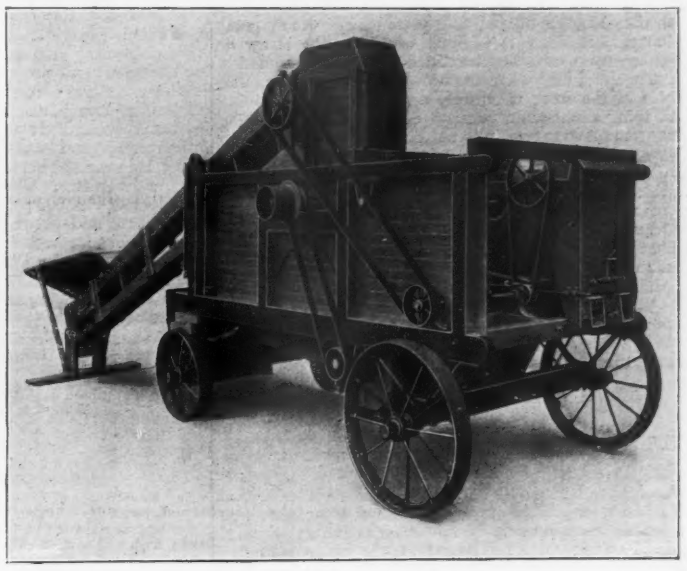


Fig. 5—FOSTER'S MAIZE SHELLER AND HUSKER

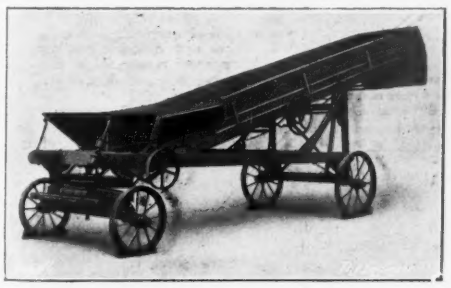


Fig. 6—FOSTER'S TELESCOPIC ELEVATOR

Of oil and gas engines the display compares favourably with those of former years, but owing to the high state of efficiency at which this form of motor has arrived, improvements are few and far between. The largest oil engine on the ground is exhibited by Messrs. R. Hornsby and Sons, Limited, Grantham. This is capable of developing 125 horse-power on the brake, using Texas oil at 2½d. per gallon. The engine has a cylinder 25¼in. diameter, and is shown driving, by means of a belt, a Brush Company's dynamo for supplying the electric light used on the stand.

Messrs. Blackstone and Co., Limited, Stamford, in addition to other implements, show an oil engine provided with a new system of vaporising and igniting. This engine will work equally well with light or heavy oils, and requires a lamp at starting only. It will retain its heat when running light, is very economical, and will pull its full load continuously. The charge is ignited by asbestos, or other refractory material, contained in a chamber to which the charge is admitted by a timing valve. This igniter is surrounded by an annular chamber—see Fig. 3—in which the oil mixed with a due proportion of air is vaporised, its heat being kept up by the explosions in the igniter. Encasing the vaporising chamber is an annular space, sufficiently hot to heat the air, which is drawn through it on its way to the vaporiser. This engine has a new form of governor which is both neat and effective. It is a combination of the centrifugal and hit-and-miss types, and is claimed to be superior to either, inasmuch as it never slips catch having once started to do its work.

Messrs. Crossley Bros., Limited, Manchester, show, in addition to a striking display of gas engines, their well-known portable oil engine and two gas-making plants. The National Gas Engine Company, Limited, Ashton-under-Lyne, confine themselves to gas engines, the largest of which is capable of developing 70 brake horse-power. The engines are shown in operation, some using coal gas from the gas mains, and others working on Dowson producer gas, a plant for the manufacture of which is provided. Other exhibitors of gas or oil engines are, the Campbell Gas Engine Company, Limited, Halifax, who show both types, one gas engine being fitted with magneto electric ignition; Messrs. Brown and May, of Devizes; the Newton Electrical Works, Limited, Taunton; Mr. R. L. Capell, Northampton; the Forward Engineering Company, Limited, Birmingham; and R. Cundall and Sons, Limited, Shipley. In this section, it may be mentioned that several ingenious adaptations of the explosion engine have been made to agricultural implements. Amongst these is Scott's motor cultivator, made by Mr. John Scott, North St. Andrew-street, Edinburgh. This is propelled by a vertical petrol motor, and is intended to be used for such a variety of purposes as cultivating, seeding, reaping and thrashing. The machine strikes us as being of rather crude design, but it is claimed that the cost of cultivation by its means is no higher than 4s. per acre. Another application of the petrol motor is shown on a self-binding harvester exhibited by the Walter A. Wood Mowing and Reaping Machine Company, Worship-street, London. The harvester is of the usual construction, with the addition of a 6 horse-power vertical single-cylinder petrol engine, which drives the machine by means of a chain. This is a combination in which we shall look for further developments in the near future. At present it appears somewhat experimental. The Ivel agricultural motor, which was designed by Mr. Dan Albone, is already familiar to our readers. This is shown by the Ivel Agricultural Motors, Limited, 45, Great Marlborough-street, London.

Messrs. Wm. Foster and Co., Limited, Lincoln, show an 8 horse-power compound spring-mounted hauling engine, fitted with three sets of speed gear, and designed to work at a pressure of 180 lb. The cylinders are steam jacketed, and high-pressure steam can be admitted to both cylinders when starting. A prominent feature of this engine is the gear changing device, which is so contrived that only one set of wheels can be in operation at once, thereby preventing stripping of teeth. Among the implements on this stand is a maize sheller and husker, Fig. 5, which is made in several sizes with the beaters or helices ranging from 3ft. 6in. up to 5ft. long. The elevator shown is made in varying lengths to suit special circumstances. The general internal arrangements are specially adapted to suit different countries, but the machine shown is largely used in South America. The husker combines in the cage of the machine a special arrangement for expanding or contracting the area of the cage, according to the class of maize cob being dealt with, an unusual feature. Illustrations are also shown of a colonial thrasher, Fig. 4, which is made with drums in sizes from 3ft. to 6ft.; and the Hayes telescopic elevator, Fig. 6, which is made in lengths ranging from 20ft. to 24ft. Messrs. Sargeant and Co., Limited, Northampton, are represented by a collection of artificial manure distributors, grain drills and slag sowers. The gearing of the manure distributors has been simplified, and adjustable; detachable spouts are now provided by means of which the material may be diverted into rows. Messrs. Thomas Robinson and Son, Limited, Rochdale, have a stand devoted to both woodworking and milling machinery, to which we shall refer again, but mention may be made here of a neat model representing a complete modern flour mill with a capacity of two sacks per hour. The machinery embraces the complete Robinson system of cleaning, conditioning and milling wheat.

Mr. H. P. Vacher, of Vulcan Ironworks, Winchester, exhibits in operation a simple pulse valve for hydraulic rams, which has a new and effective adjusting arrangement for the rubber disc. A circular disc of rubber is enclosed in a valve box forming the crown piece, and has a large hole through which the water flows. The crown piece which surmounts the disc is slightly dome-shaped, and holds the disc in place on its outer periphery It is pierced with numerous ports for the escape of the water through the crown, and when started, the water in passing through the valve escapes through the crown, and carries with it the inner periphery of the disc. This, in coming in contact with the under surface of the crown, completely closes the ports, and causes the necessary concussions. Immediately the effect of the blow is

Fig. 7—HOWARD'S LONG STRAW PRESS

neutralised, the disc assumes its first position, and the operation is repeated. The adjustment of the stroke of the valve is obtained by having a metal ring large enough to support the inner periphery of the valve, and on which it can drop, so attached to a spindle passing up through the centre of crown piece that it can be easily adjusted by a screw-thread and nut on the outside of the valve box, and whilst the ram is at work.

Messrs. J. and F. Howard, Bedford, exhibit for the first time at these shows a new long-straw press, which is designed to take the straw from a thrashing machine, and turn it out bound in convenient-shaped rectangular bales without doubling up or crushing it. The press which is worked by a belt from the thrasher drum spindle, not only makes all the straw which falls from the shakers of a thrashing machine into square-sided bales of great solidity, but does it without crushing the straw or doubling it up, and besides this, the machine binds the bales with ordinary harvest twine and ejects them. The whole of the work is entirely automatic. The banding and tying mechanism consists of a modification of the arrangement so successfully used formerly on the Howard straw trussers. When the bales emerge they are about 1ft. thick and about 5ft. long, without the straws being doubled up endwise, and the width of the bale is optional. The weight of a bale 14in. wide is 40 lb., and bales up to 56 lb. can be made by setting the regulator, which is a serrated disc, rotated by the forward movement of the straw. The machine also effects economy in the use of twine, 1 lb. of which is required for about 27 cwt. of straw. The bales are turned out at the speed of 90 to 100 per hour.

We intend to refer again to some other important exhibits in our next issue.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE summer meeting of the Institution of Naval Architects, invariably a pleasant and enjoyable, as well as profitable, part of the year's doings of this important body, has this year been held in the sister isle, and though not so remote geographically as the place of a number of the summer congresses in recent years, the interest was no less keen, and the value of the proceedings at least equal to previous gatherings. Dublin, as well as Belfast, formed the *venue* of the congress. Belfast, as the home of two of the greatest shipbuilding establishments in the world, had, of course, a powerful claim upon the interests of the members of the Institution from a practical standpoint, while Dublin, as the centre of Irish Court fashion and gaiety, had an equally strong claim on their interest from the social and holiday point of view.

Amidst bright sunshine, doubly welcome from the fact of the afternoon previous having been one constant downpour of rain, the members of the Institution—and a goodly proportion of their Belfast hosts—to the number of some 260 or 280, met on Tuesday, the 23rd, at 10.30 a.m. in the Examination Hall of Queen's College.

The Lord Mayor of Belfast, the Right Hon. Sir Daniel Dixon, P.C.D.L., welcomed the members of the Institution in terms which left no doubt of the heartiness of the reception. Following this the Rev. Dr. Hamilton, in similarly gracious and fitting terms, welcomed the visitors to the college of which he is the president. The Right Hon. the Earl of Glasgow, G.C.M.G., LL.D., president of the Institution, replied in a few well-chosen words, and thereafter, assuming the chair in his official capacity, gave a short presidential address dealing with the several staple industries of the capital of the North, and particularly, of course, with those most important, shipbuilding and marine engineering. He gave a concise *résumé* of the beginnings and growth of the two large establishments—Messrs. Harland and Wolff and Workman, Clark and Co.—and some interesting statistics as to the productive capacity and notable individual productions of the two establishments.

Records showed, he said, that the shipbuilding industry of Belfast was by no means of modern origin. Wooden sailing vessels were launched from Belfast yards in very early days. It is, however, only within the last forty years that ship construction has assumed a position of commanding importance in the district. Dealing only with quite recent times, the output of vessels built in the Belfast yards shows a very remarkable increase. Whereas in 1895, 17 vessels aggregating 95,630 tons were launched, five years later this figure had grown up to 127,000 tons, an increase of nearly 33 per cent., due chiefly to the increase in size of individual vessels. During 1902, 19 vessels aggregating 157,464 tons were launched, an amount greater than the whole output of mercantile steam tonnage of any other entire European State save Germany. Of the total above referred to, 79,500 tons were launched from Harland and Wolff's yard, and nearly 76,000 tons from Workman and Clark's yard; these two important firms, between them, turning out as large a tonnage as almost any other shipbuilding centre in the country. As regards Harland and Wolff's works, there is one name that will occur at once to the memory, that of the late Sir Edward Harland, the founder of the firm, and whose statue it would be his lordship's privilege, in response to the Lord Mayor's invitation, to unveil. Sir Edward Harland came to Belfast in 1854, and, in the course of the fifty years which intervened before his death, he converted a small and unprosperous business into the makings of the present powerful industrial establishment. Happily, the genius of Queen's Yard did not desert it on the death of the founder, and during the seven years or more that have passed since then, there has been no lack of enterprise to keep the business of the company abreast of the times. At the present time, it is a remarkable fact that out of the 70 largest vessels afloat—of 10,000 tons and upwards—Harland and Wolff have built no less than 35, of an average tonnage of 12,618. Size has always been a feature of this firm's work, and the three great ships, Oceanic, Celtic, and Cedric (the largest vessel afloat), are brilliant examples of what modern enterprise and skill can do for those who "go down to the sea in ships." To undertake the building of such vessels, and to be able to do so expeditiously and economically, it need hardly be said that advantage must be taken of every appliance that modern invention has perfected for the special class of work in view. Without forestalling the interest of the pending visit by detailing the various methods by which the difficulties incidental to ship construction have been overcome, attention may be called to the three huge hydraulic gantries, 100ft. high and 95ft. wide, erected at Harland and Wolff's building slips, and these are about to be rivalled in usefulness by the electric cantilever cranes which it is proposed to put down at the other end of the same yards. The other great shipbuilding firm, Workman, Clark and Co., has grown into importance with a rapidity which speaks highly for the business capacity of its founders and the men of the North of Ireland. This firm commenced business in Belfast in 1879 on the north side of the Lagan. In 1891 the construction of engines and boilers was commenced, and the business then grew so rapidly that three years later a shipyard was established on the south side of the river. These works now cover an area of about 50 acres in all.

The first paper, very fittingly, was by Mr. G. F. L. Giles, M.I.C.E., Engineer to the Belfast Harbour Commissioners, on the subject of "Belfast Harbour and its Development." In the unavoidable absence of the author the paper was read by the Secretary of the Institution. After concisely describing the older and still existing features of the Belfast Harbour, as respects the channels, quays, docks, &c., the author spoke of the newer and projected lines of development. The harbour is about seven miles from the seaward entrance of Belfast Lough, and approached by the new Victoria Channel, about four miles long, dredged through the intervening sand banks and slob-lands, with a width of 300ft. between the bottoms of the slopes, and a depth of 20ft. at low water. This channel was completed in 1891, at a cost of £70,000; the portion however, lying within the harbour and between the twin islands, having been completed as far back as 1849.

Of the Musgrave Channel, which branches out from the new Victoria Channel, at the north end of the East Twin Island, and is just on the verge of completion, the author says:—

> This channel at the north end of the East Twin Island, and is just on the verge of completion, the author says, extends in a southerly direction in a line parallel with the Victoria Channel for a distance of over a mile and a-half, and is 300ft. wide in its narrowest part, and 17ft. deep at ordinary low-water level. The excavations from this channel were all utilised in the reclamation of a large expanse of slob-lands lying between the west bank of the channel and the East Twin Island, comprising an area of over 100 acres. On the east side of the channel, further south, the dredgings are still being utilised for the reclamation of slob-lands, and a further area of about 70 acres is in course of reclamation thereby. At the southernmost end of the channel three wharves have been constructed of timber, and the bed of the channel has been deepened to 26ft. at low water alongside the northernmost wharf, and will be deepened to 24ft. at low water alongside the other two. These jetties will be largely used for the discharge of petroleum oil, and the fitting out of vessels built in the neighbouring shipyards. The works in connection with this enterprise were commenced in March, 1899, since which date nearly 5,000,000 tons of soil have been dredged and deposited on the adjoining slob-lands.

The harbour generally consists of docks and quays which have been opened since 1848, and give a total quayage of 23,040 lineal feet. The Clarendon Dock, the furthest up the harbour, opens into the Lagan through the Donegal Quay, the entrance being spanned by a double-road swing bridge built in 1882 at a total cost of £17,000. The dock itself, constructed in 1847-50, is 4 acres in area, and is now principally used for small coasting vessels, the depth of water being limited to about 10ft. at low tide, which, however, at the time of construction was amply sufficient for the vessels then using the port. The York Dock, with York Branch Dock—the oldest existing dock in Belfast—are together about 14 acres in area. The York Dock dates from 1889, an extension of it from 1897, and has an area of over 10 acres. It has a depth of water at low tide of 26ft. which, the author says, "is sufficient to allow any vessel likely to visit this port for some years hence to lie afloat at dead low water." Together with the large goods sheds on both sides, the dock cost £196,750. The Spencer Basin, with which the York Dock is connected, is 7 acres in extent and has a depth of from 15ft. to 20ft. at low water. It was built between 1864 and 1871, and both it and the Dufferin Dock opening out of it—3¼ acres area, 25ft. depth of water, and opened in 1871—are of rubble work faced with random rubble, and together cost about £155,000. The remaining dock is Abercorn Basin, built 1864 67 at a cost of £24,000, with rubble work similar to the Spencer Basin and Dufferin Dock, and having an area of 11 acres and a depth of 11ft. at ordinary low water.

There are at present four graving docks within the Belfast Harbour: the Alexandra Dock, contiguous to the large shipbuilding and engineering works of Harland and Wolff, and of Workman, Clark and Company; the Hamilton Graving Dock leading out of Abercorn Basin, further up the harbour; and two small dry docks dating from 1800 and 1826 respectively, leading out of the west side of Clarendon Dock. The Hamilton Dock was completed in 1867, at a cost of £40,000, and is 470ft. long, 84½ft. wide at coping level, 50ft. on the floor, and 60ft. wide at coping level at the entrance, while the depth of water over the sill at average high tide is 15½ft.

The Alexandra Graving Dock—we quote again from the paper—was until quite recently reckoned the largest dry dock in existence; it is 830ft. long, 92ft. wide at coping level, and 50ft. wide on the floor, with a depth of water over the sill of 25ft. at ordinary high-water level. It was opened by the late Prince Albert Victor of Wales in 1889. The work is executed in concrete, faced with concrete of finer quality; the entrances and coping are of granite. The cost of the dock alone was £93,448, and, including the Alexandra and Victoria wharves, &c., the total cost was about £150,000. The engines, pumps, and machinery for pumping the water from the dock were so designed that 10,000,000 gallons of water, the contents of the dock, can be discharged into the entrance basin within two hours and a-half. The engines are two pairs of horizontal compound non-condensing of 500 horse-power combined, having their cylinders placed at right angles, each pair acting direct on one crank shaft, with sweep cranks, for working with a steam pressure of 80 lb. per square inch. The high-pressure cylinders are 20in., and the low-pressure 31in. diameter, the stroke in both being 24in. At the bottom of the two pump wells are fixed two cast iron centrifugal pumps, with runners 7ft. diameter secured to the vertical pump shaft. The engines are so designed that either or both pumps may be worked at the same time. The dock is supplied with every convenience for the economical and rapid repair of vessels lying in it, and can be divided transversely by ship-shaped caissons into three different lengths of 300ft., 200ft., and 300ft. The caissons cost about £4830 each for the entrance 80ft. wide, the coping being 31ft. above the dock sill. There are several wharves and jetties in connection with the dock, and on the Alexandra Wharf is a 100-ton derrick crane, alongside of which the quay has a depth of 24ft. at ordinary low-water level.

Plans and specifications are now being prepared, and advertisements will shortly be issued for the construction of a new graving dock on a site contiguous to the existing Alexandra Graving Dock. This dock, when constructed, will be the largest in the world. It will probably be decided to make it 850ft. long, 96ft. wide at the entrance, with a depth of water over the sill of 34ft. 6in., and 32ft. on the blocks. The dock, when completed, will satisfy the pressing demand for dock accommodation suitable for the enormous vessels now in course of construction and in contemplation.

As regards lifting appliances, Belfast is fairly well supplied, the most notable being a derrick crane of 100 tons capacity, situated on Alexandra Wharf, and shearlegs of 60 tons lifting power on the eastern side of the Abercorn Basin. The derrick crane lifts 100-ton loads at a radius of 50ft., 80 tons at 60ft., and 60 tons at 70ft. It is one of the largest and finest derrick cranes in the United Kingdom, having cost, together with foundations, £13,560.

Mr. Alexander MacLaine and Mr. John Corry, as old members of the Institution, and as acquainted intimately with Belfast and its harbour in the day of small things, complimented Mr. Giles both on the work accomplished under his direction at Belfast and on his interesting account of it. Colonel Swan, of Newcastle-on-Tyne, also spoke, expressing the opinion that the enterprise and assiduous work of improvement carried out at Belfast formed an object lesson to other harbour authorities of the United Kingdom.

A paper was then read by Mr. E. H. Tennyson D'Eyncourt, on "Fast Coaling Ships for our Navy," which dealt with the question of providing specially-designed fast coaling steamers to accompany our naval squadrons when travelling at a high rate of speed, and so supply them with fuel without any delay. The subject was well reasoned out by the author, and diagrams were given of the general lines on which vessels of the kind in question might be designed, but we can only meantime indicate the leading points of the paper. The author said that in all likelihood the Government had already considered the question of building some such vessels as he proposed. Some barges had already been built which can be towed about, and have all the necessary appliances for dealing expeditiously with a cargo of coal, their carrying capacity being about 1000 tons. Some much larger vessels of a similar character, but with a capacity of 10,000 tons, were, he believed, now under construction. These, however, like the smaller barges, or "coal haul-abouts," had no means of propelling themselves, and could only be moved about very slowly by towing. All such craft lacked that most vital necessity in time of war—mobility.

It therefore appears essential that our Navy should possess a sufficient number of vessels with all modern appliances, such as Temperley transporters, for quickly dealing with coal, both in harbour, when taking it on board, and at sea, when discharging it into warships alongside; and that these vessels should also be able to keep up with a fleet—not, perhaps, with our fastest cruisers at full speed, for to accomplish this and to carry a good cargo of coal is well-nigh impossible, except by going to very large and costly ships—but certainly to keep up with our most modern armoured cruisers; that is, to be capable of maintaining a sea speed of 17 knots, and to do 18 knots in case of an emergency. If we can achieve this a great deal will have been done towards increasing the efficiency of our Navy, and we shall find that it can be done at a cost which is small when set against the immense advantages which will be gained.

The various requirements could be met by vessels of approximately the following dimensions:—Length, 550ft.; beam, 66ft.; draught of water, 27ft., with 10,000 tons of coal on board, so as to be able to go through the Suez Canal with full coal. On a greater draught, when there was no question of passing through the Canal, a greater quantity of coal could be carried; the amount would, however, be naturally limited by the cubic capacity of the holds. One, or perhaps two deep water ballast tanks should be provided for use when in the light condition.

The horse-power necessary for 17 knots at sea would be about 12,000. The machinery would be of the most economical type, with quadruple-expansion engines and cylindrical boilers, with Howden's forced draught. They would consume less than 1½ lb. of coal per indicated horse-power per hour, so that at full speed the collier could go 1000 miles from the coaling station and back on 800 tons of coal, carrying 10,000 tons of coal to the fleet, that is, enough to coal five of our largest battleships or cruisers fully, or ten to the extent of half-full bunkers, or a larger number of smaller warships.

Mr. Mackrow, of the Thames Ironworks, referred at length to a proposition made to his company five years ago or thereabouts by Lord C. Beresford concerning a screw steamer for coaling purposes to go 16 knots and carry 5000 tons. The matter had been prosecuted so far, and especially had experiments on shore been made with appliances and on systems in which his company had done much to bring about a safe and expeditious means of transferring the fuel to the vessel requiring replenishing when under progress and in disturbed waters. This was the crucial point connected with the whole problem.

Admiral Selbourne said he joined issue with the author on the main points, and spoke of the prospective exhaustion of our coal supplies; he referred very strongly to the introduction and growing use of oil fuel on board ship as indicating the lines on which effort should be expended and on which, in his opinion, progress would develop. The Admiralty, as all knew, had been carrying out experiments with oil, and all experience, he thought, went to show that comparatively few of the difficulties appertaining to putting coal on board while under way were to be faced if oil were the fuel in use.

Professor J. H. Biles said that generally he agreed with the views expressed in the paper, but courted rather the principle of the Government utilising for coaling purposes, with of course the necessary special equipment and alternative arrangement, vessels already in existence, or built for ordinary purposes of trade.

Captain Angier deprecated Government being looked to so much to assist in every line of development connected with shipping, and rather thought that private enterprise might be encouraged to provide the facilities and means connected with this subject. He projected himself into the future a bit, and referred to the time coming when there would neither be coal required for fuel nor boilers for steam raising, and a system would

obtain on board ship now in vogue so much on our motor cars on land.

Mr. D'Eyncourt, in his reply, and with reference to Mr. Mackrow's remarks as to the lengthened series of trials on land in regard to coal transference, pointed out that already very good work was being done with the "haul-abouts" at Portsmouth and Devonport, where, it is true, sea conditions are comparatively favourable. As regards Admiral Selbourne's joining issue with him, he rather thought they were quite in agreement, as the substitution of oil for coal as the fuel to be dealt with was "only a detail."

The concluding paper of the sitting was one by Mr. James Hamilton on "Mercantile Cruisers Fitted with Housing Propellers"—a subject which also, of course, had a close bearing on naval matters. It involved a consideration of the question of subsidies which Governments must expect to pay to have the call on merchant ships as auxiliaries, and in consequence the views set forth partook of an economic or commercial character as well as that due to the scientific and practical points involved. The paper—a lengthy one—was illustrated by diagrams, and by a large-scale model of the stern of a three-propeller steamer, but we must hold over further reference to it, and to the subsequent proceedings, both at Belfast and Dublin, till next week.

After the meeting, the visitors and local friends were entertained at luncheon in the Exhibition Hall of the Botanic Gardens, closely adjacent to the College, by Right Honourable Sir Daniel Dixon, the Lord Mayor, the hall being beautifully draped and decorated with growing plants and flowers. The toast list was short, only embracing "The King," and the complimentary toasts appertaining to guests and host.

An organised visit was paid to the works of Workman and Clark in the afternoon, and later the members were taken a trip in Belfast Lough by the s.s. Magic, of the Belfast Shipping Company. In the evening a reception was given in the harbour offices by the Chairman of the Belfast Harbour Commissioners, Sir James Musgrave, Bart., D.L.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

MILLING MACHINE FEEDS.

SIR,—In reference to your article of May 22nd, on end milling, or rotary planing, as I prefer to call it, and the results given in the same issue by Messrs. Alfred Herbert, of Coventry, I might mention in commencing that on my first visit to the hospitable works of Messrs. Herbert in 1897 I noticed the large amount of flat work about, all either planed or milled with cylindrical cutters, and inquired why these surfaces were not machined by rotary planing, for which I have been a strong advocate for many years. The reply given me was that this was not sufficiently accurate for their work. It would, therefore, be interesting to know Messrs. Herberts' reason for changing their opinion, as the American cutter, shown in Fig. 8, was well known at that time.

The rate of traverse given, viz., 7½in. per minute, is, apart from other things, very good, due, of course, to the high rate of cutting speed, but is more than I would recommend as profitable as general practice. One would like, however, further particulars, such as how often cutter is sharpened in constant work; secondly, let us have the total weight of the machine, as, of course, the same cutter will do more work in a large machine than in a small one; this will give us something to compare first cost. Also, are castings pickled or sand-blasted in any way, as with the cutter on a vertical spindle much of the chips and dirt lie on the work and injure the cutting edges.

In addition to the above, the question of softness of iron is important. In 1898 the *American Machinist* published particulars of feeds obtained by rotary planers in the States which ranged up to 13½in. per minute, much in advance of Messrs. Herberts' 7½in. The softness of American iron is, however, well known, and any of your readers who have to re-scrape the slides of, say, an American shaper, will know that they have to be careful not to dig too deep. Now, Messrs. Herberts are toolmakers only, having their own foundry, and with their American training and connections, it is fair to assume that their iron will be much softer at all events than the class of casting used by steam engine makers and the like in this country. The casting shown in Fig. 8 is apparently a turret slide of Messrs. Herberts' well-known heavy pattern, and should come out nice and soft, much softer, in fact, than a steam chest cover, even if made from the same iron.

I have in mind castings which my milling machines have had to tackle of iron so hard that with Mushet steel 17ft. per minute cutting speed was the limit, and there were plenty of hard spots. I tried in 1896 a sample cutter of the same design as Messrs. Herberts' in Fig. 8, and made by a well-known American firm, and this made a poor show against the older style of English cutter block. Both English and American cutters for this work have too many cutting edges, and in comparison to the single tool facing block, used in drilling and boring machines, each tool does too little work. All solid milling cutters, whether end or cylindrical mills, are being constantly made with coarser pitch teeth, and these large inserted tooth-end mills should be coarser pitch still.

I have pleasure in giving results in actual shop work from machines of my design, in all cases with horizontal spindles. This gives me an advantage over Messrs. Herberts' machine, as the chips and dirt fall away, leaving the surface clean.

(1) Machine first made in 1889, universal miller type, travelling table; cutter, 27in. diameter, 36 teeth; width of cut, 15in.; depth, ¼in. to $\frac{3}{16}$in.; speed, 2½ turns per minute, equal to 17ft. cutting speed; feed, 3½in. per minute; feed per tooth, ·038in.; cutters, Mushet steel, sharpened once in ten days; weight of machine and countershaft, 5½ tons; castings very hard and with hard spots, unpickled.

(2) Machine first made in 1893; floor type; travelling table; cutter, 40in. diameter, 52 teeth; width of cut, 32in., depth, $\frac{3}{16}$in. to $\frac{1}{8}$in. in places; speed, 1⅜ turns per minute, equal to 17ft. per minute cutting speed; feed, 3in. per minute; feed per tooth, ·033in.; cutters made of Mushet steel, sharpened once in 12 to 15 days; weight of machine and countershaft, 20 tons; castings of same quality as before.

(3) Fly-wheel milling machine, invented and patented by me with others in 1896. Revolving table; cutter, 24in. diameter, 36 tools; width of cut, 11in.; depth, ¼in. to ½in.; speed, 2¾ turns per minute, equal to 17ft. cutting speed; feed, 3in. per minute; feed per tooth, ·030in.; cutters made of Mushet steel, sharpened once in 8 to 10 days; weight of horizontal milling slide, base, and table, about 6 tons, castings of same quality as before.

(4) Patent rotary planer, first made in 1901.—Travelling head, work stationary; cutter, 11in. diameter, 8 teeth; width of cut, 8in., depth, ¼in.; speed, 7 turns per minute, equal to 20ft. cutting speed; feed, 2in. per min; feed per tooth, ·033in.; cutters made of Armstrong-Whitworth S.H. steel, sharpened once in four days; weight of machine and countershaft, 17 cwt.; castings not so hard as previous examples, but rough and cored very thin.

The foregoing will give an idea of rotary planing in a general engineer's shop, and has proved satisfactory to customers. In the fly-wheel miller, No. 3, rotary planing the face and edges of a 6ft. wheel, two cuts occupied 2½ hours, showing a great saving over even the lathe. The crown face is obtained by placing the cutter in a certain position relative to the centre of the wheel, a rather curious geometrical trick, and proved perfectly successful. Boring and bossing, although started simultaneously, took longer, making record time, four hours, and in practice nearer five hours. Owing to heavy first cost, and other reasons too long to enter upon here, the use of the machine has not become general, though the saving is undoubted, and with better designed boring apparatus would be much improved.

The patent rotary planer, No. 4, is only a small machine, being then somewhat in the experimental stage. Since then the design has been much strengthened, but further results are not at hand. A larger size is in progress, and I shall be pleased to send particulars of same in a short time. The job mentioned is facing ends of long castings used in furnace work, and there being no hole or clearance in centre a single tool facing block could not be used satisfactorily. That the cutters need sharpening as often as every four days is evidence that the machine is working hard, and in a larger machine the periods between sharpening would be much longer.

Perhaps Mr. William Pearn will give details of feeds and speeds used in his patent pipe facing machine. This will show what a single tool is capable of, used under practically the same conditions, and furnish an interesting comparison.

106, Princess-street, Manchester, JOHN TANGYE.
June 9th.

INTERNATIONAL CONGRESS OF HYGIENE AT BRUSSELS, SEPTEMBER, 1903.

SIR,—May I ask you to allow me a little space in your valuable paper to draw the attention of your readers to this Congress, which, as far as I can make out, does not appear to have received that notice which in my judgment it deserves.

The Congress has been fixed somewhat earlier than usual, so as to be more convenient as regards the time of general holidays, and it is to be hoped that when making the necessary arrangements for this purpose all interested in sanitary matters will make a point of including the Congress within their circle of holiday travels.

The general secretary of the Congress is Professor Dr. Putzeys, of 1, Rue Forgeur, Liège, Belgium, and the Secretary of the English Committee is Dr. P. F. Moline, of 42, Walton-street, Chelsea, S.W., who will, no doubt, be pleased to supply all desired information, but for the convenience of your readers I may be allowed to give a few particulars from the programme.

The Congress is divided into seven sections, as follows:—

The first section deals with bacteriology, the second with alimentary matters, the third with building and engineering matters, the fourth with industries and professions, the fifth with traffic, the sixth with administrative matters, and the seventh with colonial matters.

In all these sections various subjects have been selected with a view to elucidating thereon the latest views, and gentlemen have been asked to speak thereon who are known to be experts. In addition to this, so far as time will permit, other subjects may be brought forward for discussion after they have received the sanction of the Executive Committee.

It would be quite impossible for me to give here all the names of the readers of the various papers or their subjects, but amongst the readers of papers in the first section I may mention such names as Bordet, Denys, Gruber, Pfeiffer, Wassermann, Ehrlich, Roux, Loeffler, Malvoz, Netter, and many others, names which speak for themselves and are a guarantee that the subjects to be discussed will be fully and well treated, and that the latest researches and developments will not be omitted from the discussion.

The third section, which deals with the work of the architect and engineer, will discuss the following subjects, viz.:—

The first set of papers will be on the bacterial purification of sewage and trade wastes, and the names of the authors are G. F. Fowler, Launay, Pagliani, Rideal, Rolants.

The second subject to be discussed deals with the advantages and disadvantages of the combined and separate systems of sewerage, and here the following gentlemen have promised to contribute papers:—Buesing, Imbeaux, E. Putzeys, and Spataro. It is hardly necessary to point out that the authors in most cases occupy different standpoints, so that the *pros* and *cons* of the various subjects may be fully discussed.

The third question to be submitted deals with the sanitary precautions to be adopted in case of underground water supplies taken from limestone formations, and on this the following gentlemen will speak:—Gravelius, J. A. Howe of H.M. Geological Survey, Janet, Martel, Nicolis, Schardt, Broeck, and H. B. Woodward, F.R.S., Assistant Director of H.M. Geological Survey.

On the fourth subject of street hygiene, which embraces the whole subject of scavenging towns and the destruction of the refuse by fire, the chairman of the International Committee of Street Hygiene has promised to contribute a paper, to which will be attached the reports from the various members of the Committee, dealing with their respective countries.

The fifth question deals with the progress made during the last twenty years with the heating and ventilation of public and private buildings, and here papers have been promised by Herscher-Genests, Pfuetzner, and van Rysselberghe.

The sixth and last subject is the distribution of dwelling houses, their permanent ventilation, and the decoration of their interiors, on which Bonnier and Nussbaum have promised to speak.

I have not time to-day to deal with the other sections, nor can I do more than draw attention in passing to the exhibition of sanitary objects which will take place in connection with this Congress, but I hope I may have time before long to give a few further particulars concerning the atter.

Those who know Brussels will not require to be reminded of the charms this city possesses in many respects, and that it has only lately shown marked hospitality to the Lord Mayor of London. It is a very interesting town, and everyone ought to greatly enjoy a week spent there. H. ALFRED ROECHLING.

39, Victoria-street, Westminster, S.W., June 15th.

THE MOSELY COMMISSION.

SIR,—As one much interested in my country's welfare, I have studied the report of the Mosely Commission and the reviews thereon. Your leader on the subject, which appears in the current issue of THE ENGINEER, sets forth truly that the relative commercial success of countries depends largely upon the respective national characteristics. The Mosely Commission has been useful, inasmuch as it has facilitated a comparison of the respective commercial merits of Great Britain and America.

The present commercial situation of the former is the result of a gradual evolution of thought and practice through many generations. The British have passed through generations of successful trading on certain lines, and, as a natural result, are reluctant still to force any new line of policy. There is also, perhaps, an excess of independence in trading actions in certain quarters.

With the Americans all this is changed; here is a young nation which has a great future to carve out, and which is much less fettered by ancient custom or prejudice; they strike out independently, and with less fear of adverse criticism.

Novel ideas are very welcome, and direct remuneration for such is general. A further governing factor, perhaps a greater in its issue than the former, is climate.

A third factor lies in the natural resources of the country.

In consideration of these conditions under which commercial life is evolved, it may be said that Americans hold an advantage, and these conditions are unreversible.

If, therefore, we are anxious to improve on our commercial standing we must approach the question from a different standpoint, and give facilities so that work can be carried out with greater zeal and interest.

It is possible, then, that an exhaustive system could be arranged whereby employers of labour would come more closely into touch with their men, and thereby create a unity of interest which does not exist generally at the present.

It might be suggested that engineers in conference could take initial steps, which, in any case, could but result in good.

June 15th. B. E. YOUNG.

PORTLAND CEMENT IN IRELAND.

SIR,—In your issue of June 12th a correspondent calls attention to my articles on the manufacture of Portland cement in Ireland, noticed in your journal on May 8th, and makes special reference to the calp limestones.

Although the various layers both of stone and shale in this division of the carboniferous formation differ widely in their percentages of carbonate of lime, this fluctuation presents no barrier to their successful use for the purpose of Portland cement manufacture. Assuming that the clay present in them is of suitable quality, materials of this kind are, as a rule, to be preferred to mixtures of pure or nearly pure carbonate of lime, whether in the form of lime shells or limestone with clay or shale. In the latter case the mixture generally consists of not more than two materials, each containing a small but constant quantity of the other. The proportion of carbonate of lime to clay in the resulting raw flour is consequently easily maintained, but the mixture is entirely an artificial one, and must be ground to extreme fineness. On the other hand, in limestones which, like the calp, already contain a certain amount of clay, a mixture approximating more or less closely to that required for the production of Portland cement has been made by Nature far more effectually than can be done by artificial methods. Granted that the proper proportion of carbonate of lime to clay is maintained, the raw flour resulting in this last case is a much more perfect material than that obtained from the materials first referred to, while the flour need not be so finely ground. With modern grinding machinery and the methods now practised for drying the materials previous to grinding, an extreme degree of fineness may be obtained at a moderate cost and without skilled labour. A product giving 1 or 2 per cent. only of residue on a test sieve of 10,000 meshes to the square inch is more easily obtained to-day and at a less cost than was one giving 5 per cent. of residue on a 2500 sieve ten years ago. Moreover, by careful quarrying, the use of chemical methods for rapidly estimating carbonate of lime, and the employment of silos for storing and mixing the raw flour, no difficulty whatever need occur in the use of the calp limestone.

The fuel for burning is, as mentioned by your correspondent, undoubtedly less with the calp limestone than with many other raw materials. This is due to the perfect mixture of the carbonate of lime with the clay, which, as I have pointed out, has been to a great extent secured by Nature. It is a fact well known to cement makers that less fuel is required to burn finely ground and intimate mixtures than those that have been carelessly prepared. As regards the fuel question, I fail to see in what way too much has been made of it. Ireland certainly contains no fuel suitable for burning cement, it must be imported, and I have endeavoured to show that the manufacture may be successfully conducted under this condition. Peat is for this purpose of no value whatever, and the employment of rotary kilns would not render its use possible. The fuel necessary for these kilns is gas coal of good quality, which must be first dried and then ground to an impalpable powder.

Rosshaugh, Clitheroe, Lancashire, CHARLES SPACKMAN.
June 23rd.

STEAM JACKET RESEARCH.

SIR,—As chairman of the Committee, I cannot leave unanswered the question put in THE ENGINEER of the 19th inst., viz, "What useful result has ensued from the labours of the Steam Jacket Committee of the Institution of Mechanical Engineers?" The Committee's labours were first devoted to getting together in a convenient form for reference the results of experiments on the same engine with and without jackets, that it might be known what was the economy obtained in practice. This was followed by many careful experiments on engines in actual work, carried out by members of the Committee, resulting in the issue of three reports printed in the "Transactions" of the Institution. Anyone requiring information on the practical results of jacketing may consult the reports with advantage. It is true the Committee did hope that means might be devised to enable it to formulate something useful from the results of laboratory experiments on condensation. That, however, would have been more a matter of interpreting the action of jacketed surfaces than anything else.

As far as the practical results and jacketing engines is concerned, that is fully seen from the reports of the experiments on the engines themselves, and so far I maintain that the Committee finished their labours and issued reports of great practical value. I do not think THE ENGINEER can complain, in view of its own arguments, that the Committee did not go further and attempt to establish a physical law. The reports are a record of facts, and are useful to engineers in determining the probable economy from the application of jackets under similar circumstances. There is no general rule for all engines, and that fact has been fully demonstrated by the Committee's experiments.

The economy of the jacket on a single-cylinder engine is greater than it is on the modern triple or compound engine, and that result might have been anticipated by an engineer of common sense. At all events, it is one of the facts confirmed by experiments. Size of engine and all sorts of other considerations affect the quantitative results, but the general effect of jacketing, and its approximative quantitative economy, may be gathered from the reports. For instance, speaking from memory, the Lea Bridge triple engines only gave 3 per cent. economy by the use of the jackets, whilst some small single-cylinder engines reached 30 per cent. Speaking generally, in modern engines the jacket is now applied for other practical reasons than that of economy of steam alone.

Marine engineers and others often use jackets merely as means of warming up the engines before starting, and for constructive reasons, and sometimes they are used as air jackets. After all, we know things by experiment, and the question whether the physicist, after being trained to cultivate the necessary "vulgarity of mind,"* or whether the qualified engineer in whom that "vulgarity of mind" is innate, is the better experimentalist for determining engineering problems, I will not attempt to say.

HENRY DAVEY.

3, Prince's-street, Westminster,
June 20th.

INDIAN RAILWAYS.

SIR,—Your reviewer of Mr. Robertson's report on Indian Railways cannot have examined the report with that knowledge of the past and present necessary to fairly settle facts, or he would never have observed that, "this very candid document must have caused amazement to both the Government and the railway officials." To these officials the report came as a pleasing confirmation of the proposals they had pressed on the Government of India for many years, but which had been persistently ignored or negatived by the civilian member of Council who had passed all his previous service as a magistrate and collector, or by the Financial Department, which ever interferes in many petty details of administration.

* See Professor Turner, Royal Institution Lecture.

The principal feature in the report is the institution of an independent railway board to control the whole of the railways.

The originator of this proposal was the late Colonel L. Conway-Gordon, C.I.E., R.E., who brought it forward in considerable detail some thirteen years ago.

This proposal, had it been carried out, would at once have done away with the detailed interference which has been noticed and frequently objected to by the railway advisors of Government, but forced on them by the action of the Finance Department.

The next important recommendation is that regarding financial arrangements. These, he mentions in Art. 79 of the report, were elaborated for him by the railway officers in Simla, *i.e.*, of the Government Secretariat, and the chapter on this question plainly shows that Mr. Robertson's quarrel is not with the railway Secretariat, but with the Financial Department, which starves and has starved the railways from their very infancy.

As Mr. Robertson spent a considerable time before going on inspection in studying the records of the Secretariat of the Indian Government, it is evident to all with a knowledge of the past that the inspiration of the report has been derived from the proposals of the very officials whom your reviewer imagines Mr. Robertson is condemning, but who are, as a matter of fact, railway men of large experience, the only amateur being the member of Council.

June 17th. EX-RAILWAY OFFICIAL.

THE CONSERVATION OF ENERGY.

SIR,—Radium has excited attention very largely because it apparently contradicts the theory of the conservation of energy, but I think it can be shown that various operations go on daily in which work is done without, so far as can be seen, any expenditure of energy.

I may take first the perhaps doubtful case of those explosives which, like iodide of nitrogen, explode with tremendous violence, and yet give out little or no heat.

A more certain example is, however, the ordinary injector which forces a stream of water at high velocity into a boiler against a very heavy pressure, that may easily represent a very considerable amount of work. Thus, for example, an express locomotive will use 2000 gallons of water per hour. The boiler pressure is 175 lb. The work is the same as though the 2000 gallons of water, weighing 20,000 lb., were pumped to a height of, including friction, 400ft., or, in round numbers, 8,000,000 foot-pounds, yet the work is done without any loss of energy. Steam is condensed in doing the work, but the whole of the heat lost by the steam reappears in the water.

It may be urged perhaps that there is a loss due to friction. But if we take the ordinary "water bottle" feed for steam boilers, we shall find that there is absolutely no loss of energy, and yet the boiler is fed. A vessel on top of the boiler communicating with the steam is alternately opened to a cold-water tank and to the boiler. It is filled with steam to begin, cold water is admitted, and condenses the steam, the "bottle" fills with feed water, the water supply is cut off, and the port of the boiler is opened, then the water falls into the steam space, and so on. This mode of feeding would long since have superseded pumps, were it not that a foolish prejudice existed until recently against putting the water into the steam space.

Here there is no conceivable source of loss save external radiation, which does not count. Again, we have millions of foot-pounds of work done without any expenditure of energy.

I have no doubt that some of your readers can cite other examples. The so-called law of the conservation of energy appears to me to have no universal basis of fact to go upon, and is contradicted in various ways by our experience. At the least, it seems to me that we are on the eve of finding a new definition of the phrase necessary. TORQUE.

June 22nd.

HEAVY GUNS AND BOILERS.

SIR,—There appears to be a large amount of apathy on this most important subject, mentioned in your number of the 12th inst.—no reference by engineers of either large or small calibre appearing in your subsequent number—yet it is one which appears to involve the very life of our naval defence.

That something is wanting there can be little doubt, judging from the effects described by yourselves and others. Are these attributable to the guns or to the vessel, or to what? Are the guns allowed sufficient elasticity for their recoil? Are the boilers—of whatsoever kind—sufficiently secured? No mention of any damage occurring to the engines, which are necessarily well secured, seems to point to slackness as regards the boilers. There also arises the question as to the durability of the vessels themselves. How long will they stand this tremendous hammering strain?

For the reply to these may we not "look to our guns?"

June 24th. A.M.I.C.E.

DRILLING MACHINES AT YARROW WORKS.

SIR,—We note on page 611 of your last week's issue, in the description of Messrs. Yarrow and Co.'s Works, Poplar, the following relative to one of our machines:—"A new design of radial drilling machine by W. Asquith, of Halifax, in which all the gear wheels are enclosed in an oil-tight casing, there being no belt and countershaft." We would point out that there is a slight error in this description. While the ordinary form of cone drive is eliminated by our new improved gear box, dispensing as a consequence with overhead cone, the desired speed changes being obtained simply bymoving a lever, still a driving belt and overhead pulley are required, but the belt runs constantly upon one pulley, and is not subject to the great wear and tear inevitable in a cone drive. Of course belt drive would be altogether dispensed with in motor-driven machines.

For WILLIAM ASQUITH, LIMITED,
F. O'ROURKE, Secretary.

Halifax, June 24th.

GAS ENGINE PLANT.

SIR,—Referring to your notice in your issue of to-day of the gas engine plant to be installed by the Veladena Mining and Smelting Company, we should like to point out that we are making the gas engines. The plant consists of four of our well-known double-cylinder horizontal gas engines, each capable of working up to 500 horse-power when using producer gas and working at an elevation of 5000ft. above sea level, and one of 100 horse-power.

CROSSLEY BROTHERS, LIMITED,
D. H. IRWIN.

London, June 13th.

PISTON-ROD PACKING.

SIR,—Could you or any of your readers inform me of the name of the makers of a metallic fibrous packing for piston and pump rods, which is used in some parts of Lancashire and the North? It is evidently turned off a roll, and is in form similar to wood wool. VALVE ROD.

OIL FOR KEEPING DOWN DUST.

SIR,—In your replies to correspondents last week, page 597, you inform "Works Manager" regarding oil for keeping down dust. We may mention that our oil has been tried for that purpose by a prominent firm of engineers, and found satisfactory.

THE GLENGARNOCK CHEMICAL COMPANY, LIMITED.

Glengarnock, June 15th.

HIGH-SPEED BRASS.

THE rage for high speeds is not by any means confined to travelling, whether it be on the railways or on the common roads. Manufacturing processes have also to fall into line, and the tendency in engineering workshops is to quicken up in all departments. In handicrafts, the premium system of awarding labour has the desired effect, but this can be enhanced considerably in machine shops by the employment of what is known as "high-speed" cutting steels, with some brand of which all our readers are by this time acquainted. With characteristic energy the Delta Metal Company, Limited, Cannon-street, London, has now produced an alloy by its well-known extrusion process, aptly named "Dick-strudo," which is likely to cause somewhat of a revolution in the manufacture of small brass articles. The extrusion process, invented by Mr. A. Dick, is already well known, and articles produced by it are in common use. It consists in the squirting of heated metals through dies of almost any conceivable shape by means of hydraulic pressure, frequently exceeding 30 tons per square inch. Such pressures exerted upon the metal while in a semi-plastic condition must give a highly homogeneous product, strong, ductile, and free from the defects frequently found in ordinary castings. The process has now been developed to such a high pitch of perfection that by a judicious mixture of the ingredients a brass can be produced of almost any section which can be tooled at a speed far beyond the dreams of brass turners. Indeed, it is claimed that for small articles which have hitherto been cast in the ordinary way, not only can a better article be produced from extruded bars of the new metal, but also, on account of the enormous speeds at which they can be finished by unskilled labour, an appreciable saving can be effected in the cost of the ultimate product.

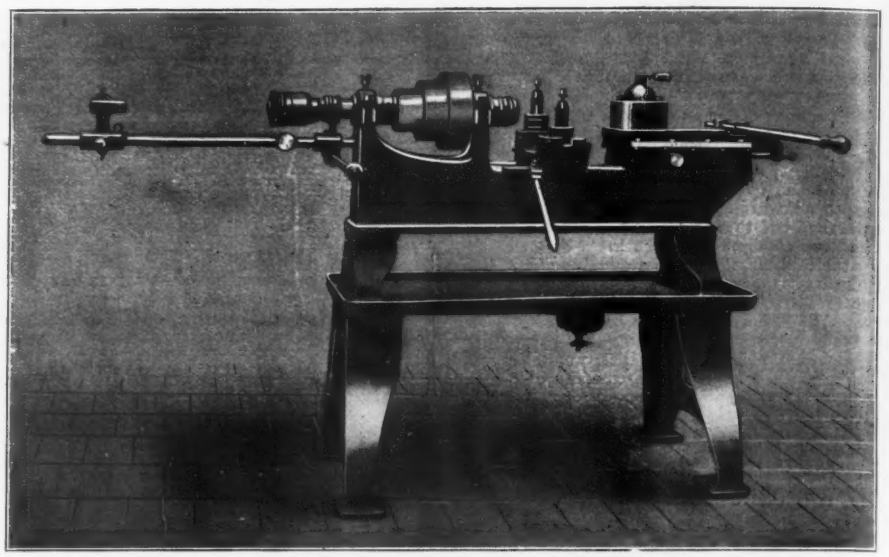


Fig. 1—CAPSTAN LATHE FOR HIGH-SPEED BRASS WORKING

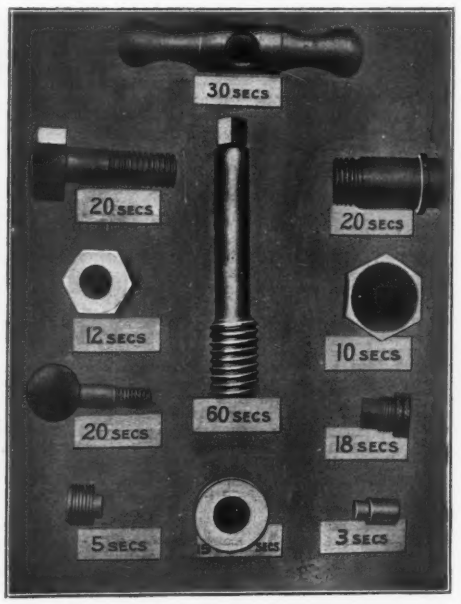


Fig. 2 SAMPLES OF HIGH-SPEED TURNING

The illustrations which we give herewith show very clearly what can be achieved in this direction. These articles were produced from rods or bars on a light capstan lathe, using best cast steel for the cutting tools without any lubrication whatever. The times occupied in their production are shown on the labels attached to each. The cutting speed was about 500ft. per minute, and the revolutions of the lathe spindle were respectively 3000 and 2000 revolutions per minute, according to the size of the bars. The ⅜in. hexagon nut shown on the right-hand side of the illustration—Fig. 2—was made from a hexagonal bar. It involved six operations, including stopping and parting. The time occupied was ten seconds, the speed of the lathe 2000 revolutions per minute, and the amount of metal removed 75 per cent. The article shown immediately below this nut is a milled nut for the pneumatic valves of cycle tires.

This was produced on a lathe making 3000 revolutions per minute, and necessitated nine operations, yet the whole was completed in eighteen seconds. The illustrations, Fig 3, represent two gas taps. That on the right was produced from the solid bar of the special metal, and the tap on the left was made in the usual manner from a brass casting. The process of making the latter needs no description, but some idea of the routine of manufacture employed in the former should be indicated. The body of the tap is formed, drilled through for gas way, opened out, "tighted" and screwed outside, reversed, chucked again, bored and tapped, then drilled and bored taper to suit the plug before being cut down; the plug is turned from the solid rod of extruded section, chucked, roughed down into the round, finished with a taper neck, cut down for the washer, drilled, and tapped. The gas way is then drilled, a hole is drilled for the pin and flats made for the washer, and finally the fan is shaped on both sides. The whole of these operations on the body and plug take only two minutes.

To enable these enormous speeds to be attained, the lathes require to be suitably built. Fig. 1 shows a capstan tool, which has been specially constructed by the Timbrell and Wright Machine Tool and Engineering Company, Limited, Birmingham, for the purpose, which appears to give satisfaction. It has been designed for a speed of 2000 revolutions per minute upon 1in. diameter rods—or 523·6ft. cutting speed per minute. The bed and headstock are one casting. The spindle is made of special steel, hardened, ground, and lapped. It is provided with adjustments for taking up wear and has ball thrust bearings. The rod feed is automatic,

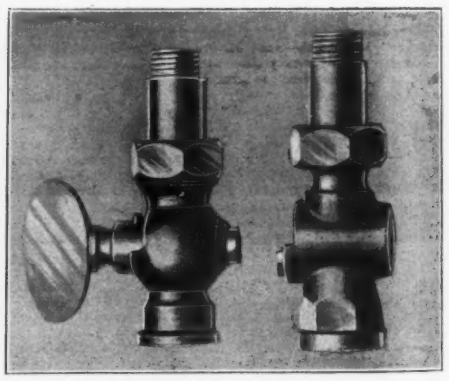


Fig. 3—GAS TAPS

enabling the articles to be produced without stopping the machines. The turret carries the tools, which are held in position by special steel grips. It either revolves automatically, enabling each successive tool to be brought instantly and smartly into operation, or can be revolved by hand. The cut-off rest is operated by a specially quick screw or lever, and is provided with two tool-holders with screw adjustments for height.

A representative of THE ENGINEER has had an opportunity of witnessing the operations necessitated in the production of some of the articles here illustrated, and was much impressed with the excellent quality of the work produced by a girl. Under the tool metal came off like paper shavings, and the finest threads were perfectly produced at the same high speeds, while the surface of the metal leaves nothing to be desired, no defects or blow-holes being visible. That there is a great future for this metal, and the method involved in producing light articles from it, is quite obvious.

THE draft French Navy Estimates for 1904 show, it is said, a decrease of £21,584. The total for next year is £12,517,571—about the same as in 1900. Generally speaking, there are slight increases on the votes which affect the commissioning of ships, additions being provided for men, provisions, and stores. It would appear as if the policy of saving by keeping the fleet in port is not to be continued. A significant fact is that the vote for the working of bases of operations is about doubled, being now £103,600, while the sum laid aside for artillery and ammunition is £90,000 greater, obviously to increase firing practice by the fleet.

THE CALCULATION OF THE WEIGHT OF CASTINGS WITH THE AID OF THE PLANIMETER.*

THE object of this graphic method is to estimate the weight of the casting, which is to be made from a given pattern, when the cross section is not a uniform geometrical figure. Such an estimate is a very important guide to the foundryman, who would otherwise guess at the probable weight of a casting of new design, and, in trying to be on the safe side, would probably melt an unnecessary amount of iron. It is also an aid to the designer of a new car-wheel pattern, who must otherwise estimate from general experience the probable weight, have test wheels made, and correct the pattern afterwards, so as to obtain the weight prescribed.

For the method here described an accurate drawing of the pattern is employed. This gives a closer result than adrawing of the wheel itself, for the following reasons:—

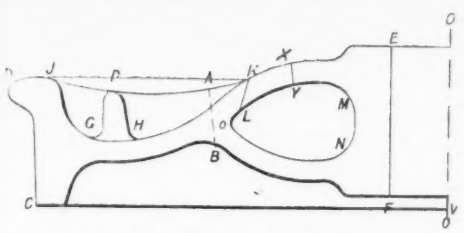
(1) Calculations based upon the actual dimensions of the wheel involve the erroneous assumption that the specific gravity of the casting is uniform throughout; and upon that basis the calculated weight would be wrong, because the amount of metal poured has shrunk in the mould, acquiring the highest density in the outside chilled portion, and growing less dense through the mottled to the grey portions.

(2) Calculations based upon the dimensions of the pattern or "chiller" assume that the cooled metal will not have shrunk, but will have the volume of the pattern and a uniform density.

These assumptions, though erroneous, counterbalance each other. For instance, the patterns and the chiller, which give a wheel of 33in. diameter when cold, are respectively 33·5in. in diameter. This shows a shrinkage for wheel iron of about $\frac{5}{8}$in.—ordinary grey pig is commonly assumed to shrink about $\frac{1}{4}$in.—per foot. Wheels cast in 33·5 chillers do not always have the same diameter. They may vary $\frac{1}{4}$in. either way by reason of differences in composition, pouring temperature, duration of pouring, and probably also slight variations in cooling. But the average diameter is 33in; and it is found that a calculation based upon the 33·5in. pattern, and the assumed uniform density of 0·26 lb. per cubic inch of molten wheel iron, as it fills the mould, gives correct weights of the wheels, even though the latter vary in size, as before explained.

For a casting of uniform specific gravity, either the drawing of the casting or that of the pattern could be used. If the latter, then a percentage for shrinkage must be subtracted.

The illustration shows, in reduced size, half the cross section of the pattern of an ordinary cast iron car wheel. From the full-sized



Cross section of half the pattern. L M N, cross section of pan core. G H P, cross section of bracket. E F C D, cross section of plates, tread, and flange. J P K, top of brackets. J K, circle of flange. C V, circle of rim. O O, centre-line of wheel axis.

drawing, divided, as shown in the figure, the areas A B C D and E F B A are taken with the planimeter, and the area L M N, similarly determined, is subtracted from their sum. The remainder is the area of the half-section of the pattern, exclusive of the brackets. Let this area—in square inches—be called A.

A blue print is then made, pasted on cardboard, cut out along the lines D E F C D and L M N L, and then balanced on a pinpoint, to determine the centre of gravity of the irregular figure. This print—*o* in Fig. 1—is located on the tracing, and its distance from the centre line of the wheel axis O *o*, is measured. Let this distance—in inches—be R. If $w = 0{\cdot}26$ lb. be taken as the weight of the metal per cubic inch, and W as the weight of the wheel, then $W = 2\pi R \times A \times w +$ weight of brackets and letters, minus weight of metal displaced by the core legs of the pan core.

The following calculation for two wheels is given as an example:—

I.

The calculation for $2\pi R \times A \times w$ was as follows:—

	No. 1.	No. 2.
Area of E F C D	52·38 sq in.	53·17 sq in.
Area of L M N	1·42 sq in.	9·60 sq in.
Net area (A)	30·96 sq. in.	43·57 sq in.
R	9·38in.	9·25 in.
Cubic contents of pattern $2\pi R \times A$	2353·6 cu. in.	2531 cu. in.
Weight (cu. cont. × 0·26)	611·95 lb.	658 lb.

II.

The requisite addition for weight of brackets is approximately calculated as follows:—

	No. 1.	No. 2.
Area, G P H	2·24 sq in.	2·30 sq. in.
Assumed average, $\frac{1}{2}$ G P H	1·12 sq in.	1·15 sq in.
Average length, measured on curve	10·5in.	10·25 in.
Volume of one bracket	11·8 cu. in.	11·8 cu. in.
Weight (vol. × 0·26)	3·06 lb.	3·06 lb.
Weight of thirteen brackets	39·78 lb.	—
Weight of fifteen brackets	—	45·9 lb.

NOTE.—The 650 lb. wheels have thirteen, and the 700 lb wheels fifteen brackets.

III.

The weight of the letters was obtained by weighing the same letters cast in lead, and taking seven-tenths of the result as correct for iron. This gave, for each wheel, 1·2 lb.

IV.

The amount to be subtracted for the metal displaced by the core legs was calculated as follows:—

	No. 1.	No. 2.
Thickness (*x y*) of bottom plate	$3\frac{3}{16}$in.	$1\frac{5}{8}$in.
Approx. av. diam. of core legs	$2\frac{3}{4}$in.	$2\frac{3}{4}$in.
Area of base of equiv. cylinder	4·4 sq. in.	5·9 sq. in.
Volume of equiv. cylinder	4 cu. in.	6·5 cu. in.
Weight (vol. × 0·26) for one core leg	1 lb.	1·7 lb.
Weight (vol. × 0·26) for three core legs	3 lb.	5·1 lb

V.

The final net weight for each wheel was determined as follows:—

No. 1 .. .. 611·95 + 39·78 + 1·2 − 3 = 649·93 lb.
No. 2 .. .. 658 + 45·9 + 1·2 − 5·1 = 700·00 lb.

The calculation for No. 1 was made from the pattern drawing for a 650 lb. wheel; that for No. 2 from the pattern drawing for a 700 lb. wheel. The cleaned wheels made from these patterns are averaging 655 lb., and from 700 lb. to 705 lb. respectively.

Since a variation of 2 per cent. above or below the regular weight can be easily caused by variable moulding in the making of a car wheel, it will be seen that the foregoing method of calculation gives reliable results. For castings of soft iron, and of more regular shape than car wheels, even better results could be obtained.

* A paper read before the American Institute of Mining Engineers, by Mr. C. M. Schwerin.

THE CIVIL ENGINEER'S CAREER LIMITED.

THE bulk of the civil engineering work done in Westminster lies, of course, in the hands of an exclusive few, of whom it may fairly be said, with the fullest recognition of the high reputations they so worthily uphold, that they are employers of other men first of all, and—*post hoc*, if not *propter hoc*—distinguished engineers afterwards. The business and position of most of them are, perhaps, nearly as much a matter of inheritance as their names; others have been able by interest to gain admission to the charmed circle; some are strong men who would not be denied; but the number of those who, alone and unaided, have forced their way through the ring-fence which is so jealously maintained is small indeed. These are the employers. The rest, the vast majority of Civil Engineers, are the employed. The chances of the most ambitious of the latter becoming one of the former are so small as to be almost negligible, and the limits of his career should be obvious to the young enthusiast from the outset.

It is not easy to find a parallel to this state of affairs in any other profession; to conceive, for example, of medical work being the monopoly of a few leading doctors, all the rest receiving appointments from or being actually employed by them. Independence lies within the immediate view of every competent young doctor. A comparatively small sum of money will place a built-up practice or a lucrative partnership at his disposal, or an older doctor may offer him a partnership on account of his professional merits alone. Otherwise, he may establish himself in a house in a neighbourhood which seems to offer an opening, put a brass plate on the door, and work up a decent practice of his own. Let—we will not say a young—but an experienced engineer with a brilliant record in India or the Colonies, or the employed engineer of one of the great firms—of whose business *magna pars fuit*—take an office in Westminster and see whether practice will come to him as it does to the doctor. How many have had the audacity to make the venture? How many have been successful?

The efficient training, both practical and theoretical, of the civil engineer requires a good deal of time and money, including, as it should, two or three years' experience in shops or on works under an engineer to whom a premium must be paid, besides a course of study at King's College, Coopers Hill, or some other great technical school in London or the provinces, or at one of the universities which grant engineering degrees. Unfortunately, the profession is not a close one like that of the solicitor, doctor, or barrister, from each of whom a certain training and a certain standard of qualifications are demanded before he can obtain professional work.

After the training the difficulty is to find an opening, or rather—since there is no such thing as working on his own account—to obtain an appointment. If his practical training has been gained as a pupil in, say, the new works department of one of the great railway companies, the young engineer may be taken on at a salary of £100 a year as assistant to a resident engineer on construction. In course of time, if he remained on the line, he might become a resident engineer himself, on a salary of perhaps £180 to £400, and in that position he might continue during the rest of his service, unless he had the good fortune to be made head of one of the sub-divisions of the engineers' office, when he might receive as much as £600 to £800 a year.

Most engineers, however, have to look abroad for a start in life—on railway construction, or irrigation, harbour, or other works—in the employ of contractors or companies, or in one of the Indian or colonial services.

Those who entered Coopers Hill in the early days, attracted by promises which have never been fulfilled, have spent the best years of manhood in bitterness and disappointment. They know by this time that it is not the policy of Governments to afford relief to those who have suffered from what amounts to a breach of faith. Governments will do nothing but modify the conditions of service sufficiently to attract new men as required. Years ago the senior men's promotion was so blocked that something had to be done, and a scheme was devised which did not help them in the least, but was of considerable benefit to junior men. A fifteen-years' retirement scheme was introduced, when the senior men had already put in seventeen to twenty years' service. Whatever professed to be a remedy was invariably applied at the wrong time to the wrong men. Many of those by whom they measured themselves when they were young, have risen to eminence in business, in finance, in the army, and other services. The question has been asked why one brother who went to Coopers Hill has done nothing particularly brilliant, while the other is a distinguished judge or soldier. The answer is obvious. The difference between the two is not one of ability, but of the limitations of the career in each case.

Apart from this matter of the grievances of one particular section of the Indian Public Works—and sympathy with the senior Coopers Hill men's cause was strong enough in the House of Commons the other day to occupy two hours of debate and to require a Government Whip to ensure the defeat of the motion on a division—the limitations of the service are very clearly defined in the distribution of honours. The irrigation engineers of India have done as splendid work as their brethren in Egypt, but C.M.G.'s and K.C.M.G.'s have been liberally bestowed upon the latter, while the achievements of the former have received the barest recognition. The reports of Lord Cromer show the most generous appreciation of his subordinates in all departments. In a Government service, of course, one does not expect the solid consolation of pounds sterling to be a prominent feature, but it would be interesting to compare the immense fees paid to the designers and constructors of important works at home with the modest salaries of those whose names are associated with the great irrigation projects, bridges, and railway works of India.

As for those who spend their lives not in a public service nor in that of a company, but on one construction work after another in South America, West, East, or South Africa, or elsewhere, with long intervals of what actors out of an engagement call "resting," it is deplorable to think of the number of capable and experienced engineers who must wear their hearts out in vain applications for posts which are practically filled before they are advertised, and in going from one office to another seeking employment.

And yet the engineer has his reward—the like of which no other career, with all its independence, wealth and honours, can offer—his work. No man can find such pleasure and compensation in his work. It is final, it remains, and he can see that it is good.—*Indian Engineering.*

SOUTH AFRICAN NOTES.

(*From our South African Correspondents.*)

The labour question.—The extraordinary antipathy to the importation of Asiatic, notably Chinese, labour for the Rand mines grows more accentuated day by day. Lord Milner has made it quite clear that as a last resort that expedient may have to be adopted, and it is firmly believed here that Mr. Chamberlain and the High Commissioner are at one on this subject. As a last resort, that is to say, should it prove to be an impossibility to obtain sufficient native labour for these mines, and should it become a question of either shutting them and ruining South Africa, or employing Chinamen, then it is probable that even the most violent of the anti-Chinese party would modify their views, provided a satisfactory scheme for controlling such imported labour could be devised. Meanwhile the agitation grows apace. Mass meetings of the Chinese now in Johannesburg are being held against the scheme, and the decision has been arrived at that steps should be taken by disseminating warnings to the Chinaman in his own country against taking employment in South Africa. As pointed out in my recent letters, however, the native labour supply is improving. The fact of the matter is, however, that the extension of the mining possibilities of the Rand is so enormous that no one can actually estimate the number of hands which will eventually be required to cope with this problem. Just after the war 100,000 was spoken of as the full complement, and then 125,000. Now the accepted minimum figure seems to be 150,000, and people are already talking of 200,000, and a quarter of a million. *L'appetit vient en mangeant*, say the French. And this proverb is being exemplified on the Rand mines to-day.

Saldanha Bay.—This important harbour within sixty miles of Cape Town, on the necessity for the immediate development of which you laid so much stress in your articles on "South Africa from an Engineer's Point of View," is to be dealt with during the short session of the Cape Parliament now sitting. Though at the time of your articles there appeared to be no prospect of the Government aiding this scheme in any way beyond authorising a private syndicate to carry out the work, it would now seem that there is a chance of a Government subsidy, and several members are in favour of making it a Government enterprise altogether.

Camels as agricultural labourers.—The first experiments with camels in Rhodesia are now being made by the importation of thirty-four from India. They are used for carrying and drawing loads and for ploughing. So far the experiment promises well, and it is expected that it will lead to a large demand. The beasts are worked by Sikh drivers who understand them, and should they turn out satisfactory should prove a formidable competitor to the motor wagon and traction engine.

Railway surveyors for Cape Colony.—The great extensions to the Cape Government Railway system make the time opportune for applications by young English engineers for employment on these railways. Recently the Government were advertising for a considerable number of engineers for the new lines at salaries of from a few hundred pounds upwards. Now they are advertising for land surveyors at £400 per annum, and 15s. a day travelling allowance and a further sum for age allowance. Applications should be sent in to Mr. A. Grant Dalton, Acting Engineer-in-Chief, Cape Government Railway, Cape Town.

Natal railways.—The sweeping condemnation of the Natal Government Railways contained in the report of a Special Railway Commissioner who was appointed to investigate the methods of that system, of which I recently sent you particulars, has elicited an explanatory reply from Sir David Hunter, the general manager of the N.G.R. The reply takes the form of a letter to the Minister of the Interior. In it he maintains that the Commissioner's report had been conceived as if an organisation and present circumstances had been the result of a deliberate and settled plan, instead of being the outgrowth of a generation in which fluctuations of South African affairs had been extreme, viz, great prosperity and sharp adversity following with a rapidity which are probably unparalleled in the history of any railway enterprise. A more unfavourable time for an inquiry could hardly have been chosen. The war was still in full operation when the Government was asked to appoint a Commissioner, whose arrival synchronised with the period of the greatest pressure yet brought to bear on the railway system, and before there was time or opportunity for getting back into the normal conditions, which even now are still a long way off.

Difficulties with white artisans.—While abuse of employers in South Africa is often the order of the day for not giving white men a proper chance, it is only fair to give the other side of the medal. As pointed out by your recent Special Commissioner, the great lodestone which attracts the white man here is Johannesburg. Mechanics and artisans who come out under contract to work for a time in Cape Colony and Natal usually migrate to the Rand or Rhodesia at the earliest opportunity on account of the higher wages. This is only natural and right when their contracts have expired, though the extra cost of living in those places sometimes counterbalances any improvement there may be in their salaries. The fact is, however, that the temptation is often so strong that these men leave their employers at the coast before they have worked out their contracts. This has been the case with nearly all the artisans recently brought out from England under contract to work in Natal on the building extensions. They broke their contracts and left for Johannesburg soon after arrival, and this without refunding their passage money to this country, as stipulated in their agreements.

Dutch natives views as to preferentialism.—It is hardly to be expected that when the average Englishman at home and abroad has only as yet been able to form the vaguest of notions as to the merits of Mr. Chamberlain's proposed fiscal reforms, that the Dutch out here should have any but very crude ideas on the subject. Mr. Hofmeyer, the uncrowned king of the retrogressives, and consequently the ruler of Cape Colony to-day, has, however, pronounced himself as in favour of preferentialism for the Empire. This sounds very promising until we read the figures. The gist of his proposal is, however, that there should be a 2 per cent. preferential tariff on both sides, and is merely intended as a means of counteracting Lord Milner's suggestion for a much larger percentage.

AUSTRALIAN NOTES.

(*From our own Correspondent.*)

TWO circumstances have occurred in New South Wales that will materially benefit the prosperity of the State. One is the general rains that have fallen all over the country, which are already bringing up the grass, and enable the farmers to commence ploughing operations, and the other is the stoppage of the unnecessary Government works, in consequence of the shortage of funds. This is now putting a stop to the fictitious value of unskilled labour. For some time past the Government has been offering a minimum wage of 7s. per day for unskilled labour, which has attracted men from legitimate employment, and public works out of loan funds have been kept going mainly to keep the men in employment. Private enterprise has consequently been stifled, added to which are the exactions of the unions in the Arbitration Court that is stopping a lot of capitalists from embarking in enterprises in these States.

The work of constructing the new central railway station, Sydney, has now been indefinitely postponed.

During the year 1902 the output of gold in Queensland was calculated at 860,543 oz. crude, equal to 640,463 oz. fine, valued at £2,720,639, an increase over the previous year of £178,747. Minerals, other than gold, were valued at £589,961. Tin, 2085 tons, valued at £116,171; silver, 701,312 oz., valued at £70,145; lead, 267 tons, valued at £2706; coal, 50,131 tons, valued at £172,286; copper, 3784 tons, valued at £189,200; opal, valued at £7000; wolfram, valued at £1167; manganese, 4600 tons, valued at £16,989; bismuth, valued at £123.

All the principal towns in New Zealand are going in for electric lighting and electric trams. Wellington City Council has accepted the tender of Macartney, M'Ilroy and Co. for the whole of the plant required for the new city tramways, excepting the power house. The amount of the tender, without boilers and tanks, was £112,884.

On the advice of Mr Goodman, agent for Noyes Brothers, a proposal has been submitted to the city authorities at Auckland for the electric lighting of the city and suburbs in place of gas. For the city alone it is estimated that the cost of the system would be £74,000, yielding a net return of £5926, which includes a sum of £7394 from motive power to be supplied. The area lighted would be about 18 miles of streets by arc lights, and 36 miles of streets by incandescent.

The Railway Commissioners' report of the working of the New South Wales railways for the quarter ending March 31st last shows a decrease of £117,539 in gross earnings, as compared with the corresponding period of the previous year, while the expenditure is £1841 less.

Owing to the Easter holidays falling in April this year, the

coaching traffic shows a decrease compared with the corresponding quarter of last year to the extent of the holiday traffic.

The increased expenditure is mainly due to special concessions made in the carriage of starving stock and on fodder for starving stock—the extension of the eight-hour system to the running staff and to increased tonnage.

The following return shows the state of the traffic :—

Railways.

	Quarter ending March 31st, 1902.	Quarter ending March 31st, 1903.
Miles open	2,990	3,138¼
Revenue	£923,500	£815,961
Expenditure	£508,691	£506,850
Train miles	2,929,217	2,736,433
Earnings per train mile	6s. 4¼d.	5s. 11¼d.
Expenditure per train mile	3s. 5¾d.	3s. 8¼d.
Expenditure to earnings, per cent.	54·49	62·12
Passengers, number	7,765,128	8,116,823
Goods traffic, tons	534,248	392,271
Coal traffic, tons	871,890	1,033,124
Other minerals traffic, tons	80,040	93,321
Live stock traffic, tons	66,438	80,815

Tramways.

Miles open	103¼	121¾
Revenue	£172,877	£199,789
Expenditure	£131,672	£199,789
Tram miles run	2,244,851	3,695,377
Earnings per tram mile	1s. 6¼d.	1s. 1d.
Expenditure per tram mile	1s. 2d.	10¼d.
Expenditure to earnings, per cent.	76·17	78·58
Passengers carried, number	28,624,112	35,142,404

LAUNCHES AND TRIAL TRIPS.

HARALD, steel screw steamer; built by, Wm. Gray and Co., Limited, West Hartlepool; to the order of, Mr. L. H. Carl, Copenhagen; dimensions, 290ft., 40ft. by 20ft. 6¾in.; engines, triple-expansion, 21in., 33in., and 56in. by 36in., pressure 160 lb.; constructed by, Central Marine Engine Works of firm; the trial was satisfactory; trial trip, June 9th.

CLAN MACLEOD, steel screw three-deck steamer; built by, Furness, Withy and Co., Limited; to the order of, the Clan Line; dimensions, 400ft. long, and total capacity 411,000 cubic feet; engines, triple-expansion, 26in., 43in., 71in. by 48in., pressure 200 lb.; constructed by, Richardsons, Westgarth and Co., Limited; launch, June 10th.

ISLE OF LEWIS, steel screw steamer; built by, the Tyne Iron Shipbuilding Co., Limited; to the order of, the Isles Steamship Company, Limited, Newcastle-on-Tyne; dimensions, 323ft., 47ft. by 25ft.; engines, triple-expansion, 24in., 40in., and 64in. by 42in., pressure 160 lb.; constructed by, North-Eastern Marine Engineering Company, Limited; launch, June 11th.

SWANLEY, steamship; built by, David and W. Henderson and Co., Limited; to the order of, Messrs. Harris and Dixon, London; dimensions, 405ft., 51ft. 3in. by 29ft. 6in., gross tonnage 4650; engines, triple-expansion, 27in., 45in., and 73in. by 48in., pressure 180 lb.; constructed by, builders; everything worked satisfactorily; trial trip, June 12th.

GUIDO, steel screw steamer; built by, Craig, Taylor and Co., Stockton; to the order of, Terneuyensche Vrachtvaart Maatschappy; dimensions, 270ft., 38ft. by 20ft. 4in.; engines, triple-expansion, 19in., 31in., 51in by 33in., pressure 180 lb.; constructed by, North-Eastern Marine Engineering Company; a speed of 10½ knots was maintained.

KNUTSFORD, handsome steel screw steamer; built by, Robert Stephenson and Co., Limited, Hebburn; to the order of, Mr. R. B. Stoke, Manchester; dimensions, 340ft., 47ft. by 29ft. 10in.; to carry, cargo; engines, triple-expansion, pressure 163 lb.; constructed by, Richardsons, Westgarth and Co., Limited; launch, June 15th.

GREENWOOD, steel screw collier; built by, Blyth Shipbuilding Company, Limited; to the order of, Tyneside Line, Limited; dimensions, 225ft. by 33ft. 2in.; engines, triple-expansion, 18½in., 30in., 50in. by 36in., pressure 180 lb.; constructed by North-Eastern Marine Engineering Company; on the trials a good speed was maintained; trial trip, June 16th.

HUSSAR, steamship; built by, Tyne Iron Shipbuilding Company, Limited; to the order of, Messrs. Fisher, Renwick, and Co., Newcastle; dimensions, 220ft., 33ft. by 17ft.; engines, triple-expansion, 17in., 28in., 46in. by 33in., pressure 180 lb.; constructed by North-Eastern Marine Engineering Company; trial was satisfactory; trip, June 18th.

FREKE, steel screw steamer; built by Chantier Naval Anversois Company, Hoboken; dimensions, 190ft., 30ft., by 12ft.; engines, triple-expansion, 17in., 28in., 46in., by 30in., pressure 160 lb.; constructed by, North-Eastern Marine Engineering Company, Limited; trial trip, recently.

HABALD; built, by Joseph L. Thompson and Sons, Limited; to the order of, Messrs. Brunsgaard, Kiosterud, and Co., of Drammen; dimensions, 337ft. 3in., 48ft., by 24ft.; engines, triple-expansion, 24in., 39in., 65in., by 42in., pressure 180 lb.; constructed by, George Clark, Limited; trial trip, June 21st.

THE RAILWAY CLUB.—The last meeting of the Railway Club for the present session was held at the Memorial Hall, Farringdon-street, E.C., on Wednesday, the 17th of June. Mr. Bruce, sen., took the chair at 7.30 p.m. An interesting paper was read by Mr. J. F. Cairns on the "The True Position of Electricity on our Railways." The history of electric railways and tramways was first considered, the existing electric lines in this country, in America and on the Continent—particularly those in Italy—were next described, the lecturer finally outlining the future possibilities of electric traction. A long discussion followed, and it was generally agreed that although electric traction would largely supersede steam on suburban lines—more especially those running underground—yet the great initial cost of installing electricity on main lines, together with the many difficulties and uncertainties as to cost of working, would delay the ultimate adoption of electric traction for main line and general railway purposes for a very long and indefinite period.

ROYAL INSTITUTE OF PUBLIC HEALTH.—The Liverpool Congress will be held from July 15th to 21st, 1903. The president is the Earl of Derby. All meetings of sections will be held in University College, Liverpool. There are nine sections:—(1) Sanitation of congested areas and rehousing the dispossessed. (2) Preventive medicine and vital statistics. (3) Bacteriology and comparative pathology. (4) Tropical sanitation. (5) Municipal hygiene and sanitary legislation. (6) Engineering. In this section, after an address by Mr. Deacon, the president, the following subjects will be discussed: "Sewage Effluents and the Construction of Filter Beds," by Professor Rubert Boyce, M.B., F.R.S.; "Traction on Road Surfaces," by Professor H. S. Hele-Shaw, LL.D., F.R.S., M. Inst. C.E.; "Mechanical Road Vehicles for Public Works," by Mr. T. Molyneux; "The Disposal of Town Refuse," by Professor Antony Roche, F.R.C.P.I; "Utilisation of Destructor Products," by Mr. J. A. Brodie, M. Inst. C.E.; "Past and Present Modes of Collecting House Refuse," by Mr. F. W. Bowden, Assoc. M. Inst. C.E.; "Construction and Maintenance of Carriage Ways," by Mr. F. E. Cooper, Assoc. M. Inst. C.E.; "Road Construction and Maintenance," by Mr. Hector F. Gullan, Assoc. M. Inst. C.E. (7) Child study and school health. (8) Port sanitary administration. (9) Ladies' Committee and section of domestic sanitation.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE engineering trades continue active, and a good deal of structural work is about, which is likely to be further augmented before long by the requirements of the Netherlands Colonial Minister, who is needing a quantity of iron and steel bridge work, together with steel rails, tip wagons, sets of wheels and axles, and other railway and tramway equipment. The various electrical engineering establishments are busy, and some good orders are also in hand by steam and gas engine builders for engines for driving electric lighting and power plant.

The present is a rather favourable time for obtaining engineering material, since prices favour consumers, and inquiries made on 'Change to-day—Thursday—show that a considerable amount of business is likely to be transacted at the forthcoming quarterly meeting.

Tramway engineering matters are creating a good deal of attention in the city, and the progress is being watched with interest of the Birmingham District Tramways Bill, promoted by the City of Birmingham Tramways Company, the Birmingham and Midland Tramways Company, and the British Electric Traction Company, and the local authorities of the districts surrounding Birmingham, before the Select Committee of the House of Lords. Alderman Cook, in reply to an interviewer on Monday, expressed satisfaction at the success of the Tramways Committee and their counsel in securing the rejection of the application of the British Electric Traction for compulsory rights of trading in Birmingham. Personally he saw no difficulty whatever in bringing about an arrangement whereby the cars of the surrounding authorities or those of the British Electric Traction Company should be brought into the city in return, or in bringing about a reciprocal arrangement by which the city cars would be taken into the suburbs, in a manner akin to that in which through carriages are run over the railways of two or more companies. The Tramways Committee had the best wishes towards the authorities of the outside district. Nor would Birmingham offer any obstruction to the prompt conversion of the tramway system into electrically-equipped routes. On the contrary, they would be willing to come to an arrangement with the British Electric Traction Company whereby this equipment should take place at once under conditions whereby that company would share the advantages and be indemnified against loss.

A resolution has been carried by the Wolverhampton Town Council, sitting as a committee, to the effect that the Corporation, before proceeding to agree to arbitration proceedings being entered upon, approach the Lorain Company again, with a view to a settlement being, if possible, arrived at.

Some fine hydraulic machinery by Tangyes, Limited, of Birmingham, has been installed at the two new reservoirs near Tottenham, constructed by the East London Waterworks Company. The reservoirs have a capacity of 1198 million gallons, and a water area of over 164 acres. The machinery for filling these reservoirs consists of three sets of 36in. centrifugal pumps, driven by vertical coupled compound surface-condensing engines, having a steam pressure of 140 lb. The three sets of pumps are capable of delivering 4½ million gallons per hour. The firm were represented at the opening ceremony a few days ago by Mr. Lincoln Tangye, the ceremony being performed by Mrs. Lockwood, wife of Colonel Lockwood, chairman of the company.

A very successful year has been experienced in the weighing machine construction trade, and some good orders are in hand for weighbridges upon agricultural and railway account. Chief among the firms in this district who have done well in this class of trade lately are W. and T. Avery, Limited, who have just declared a dividend of 5 per cent. on the preference shares, and a dividend at the rate of 15 per cent. on the ordinary shares, making 10 per cent for the year. They are also able to place £12,000 to the reserve fund, thus bringing it up to £75,000, and they carry forward £6000 to next account.

A satisfactory year has been experienced by Elliott's Metal Company, who have declared a dividend of 5 per cent. on the preference shares and the same on the ordinary shares, besides placing £15,000 to the reserve fund. No credit has been taken in the accounts for the rise in the price of copper, the stock of which has been valued on a somewhat lower basis than last year. For reasons given in the last report, the directors do not yet consider it necessary to make further depreciation, but all buildings, plant, and machinery have been fully maintained as heretofore out of revenue. The retiring directors are Messrs. J. Arthur Kenrick and Walter Chamberlain, who, being eligible, offer themselves for re-election.

A good account of business was able to be given by the chairman at the fourteenth annual meeting of the Mint, Birmingham. In proposing the adoption of the report, which recommended a dividend of 10 per cent., the chairman said the balance-sheet and profit and loss account were very satisfactory. They would also add £2000 to the reserve account, which would then stand at £66,000. The chairman further explained that it was necessary for their business, in order that they might be able to deal promptly with big orders, to have a large reserve. Competition was keen, and was likely to remain so, but important orders had come in since the closing of the accounts, which he hoped would yield a good profit for next year. It was interesting to note that during the last fourteen years they had made a profit of £191,971, and had paid away in dividends £108,642, on a capital of £80,000. He did not think the shareholders could complain of receiving 128 per cent. in 14 years. In addition to that they had built up a reserve fund of £66,000, and had written off £21,000 for the goodwill, which only stood at £10,000 at the present time.

The important extensions which are going forward at the Saltley works of the Metropolitan Amalgamated Railway Carriage and Wagon Company will, when completed, render that concern one of the best equipped in the kingdom for the rapid execution of orders. An excellent account of business was given by the speakers at the annual meeting of the company, in Birmingham, on Tuesday, and large economies were stated to have already taken place since the amalgamation was accomplished.

NOTES FROM LANCASHIRE.

(From our own Correspondent.)

A FAIR amount of activity is being maintained in most branches of engineering, and, although any real pressure of work is exceptional outside electrical and the locomotive and railway carriage building sections of the trade, there are very few complaints of actual slackness. New orders, however, still come forward indifferently, and the prices obtainable are not by any means so remunerative as engineering firms would like. The situation, however, except that there is a great deal of uncertainty about the future prospects of trade, with a disposition in some quarters to take rather a pessimistic view of the outlook, is, on the whole, not unsatisfactory, and there would seem to be no real ground for discouragement so far as the leading Lancashire industries are concerned, the present disorganisation of the textile trades caused by the abnormal high price of cotton being perhaps the most serious matter of local concern.

At the Manchester 'Change meeting on Tuesday there was, if anything, perhaps a tendency towards more firmness in pig iron prices, at any rate on transactions for prompt delivery, and a fair amount of business was reported as passing through. The position, however, scarcely showed much improvement as to the future. The cessation of buying on American accounts, and the postponement of deliveries where iron has already been bought, with a continued absence of general activity in the home iron-using industries, still bring on the market low cut forward quotations where operators are of a speculative turn. Although there was a stiffening in quotations for most brands of pig iron, except in Middlesbrough, quoted rates did not show any appreciable advance. Lincolnshire makers held a special meeting on Friday, which it was understood had been called for the purpose of considering the desirability of restoring the minimum list basis rates to those ruling prior to the reduction of 6d. per ton made the previous week, but no alteration in price was decided upon. The ordinary fortnightly meeting of Lincolnshire makers, however, is held on Friday this week, and if there is a continued hardening in Middlesbrough, prices will no doubt then be dealt with in the direction of some upward move. In the meantime, makers who are fully sold for all their present output are declining to entertain new business—except from special customers—at current rates, which remain nominally 50s. 6d. net for No. 3 foundry, delivered Manchester. Lancashire makers who found it necessary to follow the recent reduction in Lincolnshire, are quoting generally 54s. 6d. up to 55s. net, with Derbyshire brands still ruling low, from 54s. and 54s. 6d. up to 55s. net according to brand, delivered Manchester.

Forge iron remains without quotable change from last week, the lowest priced brand being Derbyshire, which is quoted about 49s. 6d., with Lincolnshire to be got from 50s. to 50s. 2d., and Lancashire about 50s. 3d. net delivered Warrington. Middlesbrough iron has again slightly stiffened upon previous quoted rates, and delivered by rail Manchester averages about 55s. 1d. net. Scotch iron is perhaps also a trifle stronger, and delivered Manchester docks, is quoted about 57s. 9d. to 58s. Eglinton, 59s. 9d. to 60s. Glengarnock, and 61s. Gartsherrie net.

Finished iron makers in some cases report that new orders are not quite so difficult to get at current rates, but generally only an indifferent sort of business is still being put through, and the principal forges continue short of work to keep them anything like fully going. For Lancashire bars the basis quoted rates remain at £6 8s. to £6 10s.; for North Staffordshire £6 10s. to £6 15s., delivered in the Manchester district, and it is only in special cases where there are sellers at materially under these figures. There are, however, reports of common German bars having been delivered recently at Lancashire ports at extraordinarily low figures, which would represent about 20s to 30s. per ton below English prices, but as German bars are sent over with rough ends a considerable margin in price has to be allowed for these. Sheets and hoops are without quotable change from last week. Delivered Manchester, quotations for sheets remain about £8 to £8 2s. 6d., with the Association basis for hoops still £7 2s. 6d. random to £7 7s. 6d. special cut lengths, and 2s. 6d. less for shipment.

In the steel trade a fairly steady position is the general report. Hematites are maintaining late rates ranging from 66s. 6d. and 67s. to 68s. net as the quotation for No. 3 foundry delivered Manchester, and local made billets remain about £4 15s. Except that very low prices, in some cases are still quoted for bars, angles, and common plates there is no real change in the general quotations, and steel boiler-plate makers are firm at the prices which have been ruling for some time past, with moderate specifications coming forward. Steel bars average about £6 5s. to £6 7s. 6d., with special quotations £6 10s.; angles are to be bought at £6 10s. to £6 12s. 6d., common plates £6 5s. and £6 7s. 6d., with £7 as the quotation of non-associated makers, and £7 2s. 6d. as the list basis of the Association makers for steel boiler specifications, delivered in the Manchester district.

In the metal market the drop in raw material has been followed by a further reduction of ¼d. per lb. on brass tubes, and ½d. per lb. on copper tubes, which is to be followed by similar reductions in copper and brass wire, sheets, and strips. Quotations for delivery Manchester are now about as under:—Solid drawn brass tubes, 7¼d.; seamless copper tubes, 9d.; brazed copper tubes, 8¾d.; yellow metal plates, 6d. per lb.

On Monday about eighty members of the Manchester Association of Engineers visited the works of Messrs. Alfred Herbert, Limited, the Daimler Motor Company, Limited, and the Motor Manufacturing Company, Limited, at Coventry. The chief interest centered of course in the works of Alfred Herbert, Limited, who take the lead in this country in the manufacture of all the smaller type of automatic machine tools. Their works, which have recently undergone very considerable extension, with further enlargements in progress, occupy about 100,000 covered square feet in shops in which there is installed a plant of 450 tools, mostly of a special design, and the firm give employment to 930 hands.

Amongst special departments which attracted attention were the fitting shop, which is divided as far as possible into sections, with the object of keeping each gang of workmen continually employed upon the same class of work. This enables a higher grade of work to be produced at a low cost. In this connection it was noted that separate departments were devoted to the building of headstocks, capstan slides, automatic screw machines, &c., and all turrets were being bored in position from their own spindles. In the turning department there were several special machines, including cone pulley turning lathes, by means of which all the steps on a cone pulley are turned and crowned simultaneously, and also all the radial faces; and special machines for boring out hollow lathe spindles. Amongst the boring tools was a three spindle machine for boring out the main bearings, the back shaft bearings, and the clutch shaft bearings and headstocks.

The turret lathe department contained about seventy turret lathes and capstan lathes of various types, and a complete line of automatic screw machines. On bar work there were twelve automatic screw machines for producing all kinds of standard screws, pins, collars, &c., from the bar, also a number of hexagon turret lathes producing longer work, and a special feature was that all reductions in diameter on the hexagonal turret lathes are taken at one cut. In the milling department were seen many special examples of gang and form milling with numerous fixtures used both for setting the work and setting the milling cutters for repetition work; also a number of automatic American machines, nine of which were being operated by one man and a boy.

The visitors generally were much impressed by the speed at which the planing machines, which are the standard American type, were being driven. The average cutting speed was stated to be about 45ft. per minute, but in some instances as high as 60ft. was attained on mild steel. The works are at present partly driven by means of belts and partly by means of motors; where motors are used the machines are grouped, the various line shafts being driven by the motors.

The Motor Manufacturing Company, Limited, whose works were next visited, was one of the pioneer companies in the motor industry, and under the management of Mr. Geo. Iden, M.I.M.E., one of the most complete plants for the manufacture of motor cars in Great Britain has been installed with a view to manufacturing the car in all its details on the premises. The Daimler Motor Company, whose works immediately adjoin, was founded in January, 1896, for the construction of the Daimler system of engines and carriages, and these are also well equipped with special machinery and plant.

At the conclusion of the round of visits a very cordial vote of thanks was, on the motion of Mr. E. G. Constantine, the president, seconded by Mr. Henry Webb, passed to the principals and representatives of the various works visited, Mr. Henry Webb remarking that Alfred Herbert, Limited, who were in the van of progress so far as automatic machine tools were concerned, had adapted the best American ideas to English requirements and improved them by introducing English stability and excellence of workmanship. Mr. Herbert, in responding, said that he felt it not only a pleasure but a compliment that the members of that Association should have travelled from Manchester to visit their shops, and he should be glad at any future occasion to afford every facility for any members of the Association who might wish to make a further inspection of the works. Mr. Harmer, chief engineer, Alfred Herbert, Limited, and Mr. George Iden, M.I.M.E., of the Motor Manufacturing Company, also responded.

A continued slackening off in the demand is the general report throughout the coal trade of this district, and collieries are being put on lessened time, many of the house-fire coal pits not having put in more than two to three days, whilst four days has been about the full average generally during the past week. Not only is the demand for house-fire qualities extremely limited, which is only to be expected at this time of the year, but other descriptions of fuel do not meet with more than a moderate inquiry. Common round coals suitable for steam and forge purposes are moving away, but indifferently, and with plentiful supplies there is a weakness in prices for prompt delivery, special late rates being quoted to effect clearance sales of surplus output. On forward contracts, however, collieries are mostly holding with firmness to their prices, but in the meantime many large users are covering their present requirements by purchasing cheap special lots in the open market, and deferring the settlement of contracts. At the pit mouth common steam and forge coals do not average more than 8s. to 8s. 3d., with better qualities quoted 8s. 6d. to 8s. 9d. With the lessened time at collieries, slack is not quite so plentiful, but there are still ample supplies on the market, especially from some outside districts, and prices are not more than maintained at late rates, averaging 4s. 3d. to 4s. 9d. for common; 5s. to 5s. 6d. medium sorts; 6s. and 6s. 6d. for the better qualities, up to 6s. 9d. and 7s. for some of the special sorts of slack.

For shipment there are very low quotations to secure clearance cargo sales, and 9s. is reported, with 9s. to 9s. 3d. very general figures, although the ordinary quotations are not under 9s. 6d. to 9s. 9d. delivered at the ports on the Mersey.

Coke continues in active demand, and maintains late rates, but there is not quite that hardening tendency which was noticeable recently.

Barrow.—There is a steady demand for hematite pig iron, and, generally speaking, the prospects of trade are very satisfactory, but it is evident that very little more business will be done for some time at least with America, as inquiries are falling off, and the orders held on American account are being gradually worked out. There is, however, a very good demand on home account, and particularly from steel-making firms, while colonial business is very satisfactory, and a few cargoes are going regularly to the Continent. There are 33 furnaces in blast, compared with 36 in the corresponding week of lrst year. A further shrinkage in stocks is noted of 690 tons, bringing the aggregate of metal held in stores to 18,154 tons, or a reduction of 6149 tons since the beginning of the year. Makers still quote 59s. 6d. for mixed Bessemer numbers net f.o.b., while warrant iron sellers are at 58s. net cash, buyers 3d. less. The settlement price of warrant iron is 57s. 9½d. Forge and foundry iron are quiet, and very little is likely to be done in lower-grade hematites while prices are so high. Spiegeleisen is in good demand.

Iron ore is in very full request, and orders are being freely booked at about 12s. per ton net at mines for good average sorts. Best ores are at 16s. per ton, and Spanish ores, which are being largely imported, are at 16s. 6d. net at West Coast ports. A find of iron ore is reported this week at Newton, near Barrow, in the face of an open working at a limestone quarry. Mr. W. Woodhouse, who works the quarry and owns the royalty, came across a vein of hematite ore only 1ft. in thickness, but in following it up he finds it is already 2ft. 3in. in thickness, and is broadening out the further it goes. There are indications this will prove a valuable find, and the ore is of very rich quality.

Steel makers are not so well off for orders requiring prompt attention, but they are well sold forward, and expect to get hold of orders to keep their mills fully employed. Plates are quiet, and only a small business is doing in heavy castings and hoops, but chilled castings are brisk, as also are billets, slabs, and general merchant steel.

Shipbuilders are quiet, but it is reported that an order has been placed for a small Irish lightship steamer, and that other orders for ships are pending.

During the past week the shipments of iron have been 5349 tons and steel 6437 tons, a decline in iron of 1742 tons and in steel a decrease of 5259 tons. The shipments of this year have now reached 197,511 tons, and steel 273,244 tons, an increase in iron of 511 tons and in steel an increase of 13,730 tons.

Coal and coke in poor demand. Prices are low, competition keen, and supplies very full.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

ALTHOUGH it is said that prices of house coal are considerably easier for large buyers, the benefit so far has not extended beyond the merchants to the consumers. There has been a weakening of values, but it has not been sufficient to give the householder much relief, and the weather has been too uncertain to make it safe to leave off buying. Business generally fluctuates from day to day. On the whole, however, it is not unsatisfactory, many of the pits making excellent time. The quality of domestic coal most largely used, Barnsley House, still fetches 11s. per ton in the best qualities; secondary sorts are from 1s. to 1s. 6d. less.

In steam coal there is a good business doing both on home and foreign account, and quotations are as high as they have been during the whole year. The South Yorkshire pits are sending very heavily to Hull and other Humber ports. It is satisfactory to observe that Denaby and Cadeby Main, after their prolonged strike, are now taking their old position as the principal contributors of steam coal export supplies. The railway companies have been receiving heavy deliveries, which are not likely to be diminished as the season progresses, and other customers are finding a full average trade. In the ordinary market quotations still keep at 3d., 6d., and 9d. per ton above the contract price of 9s. per ton.

Perhaps the chief feature in the coal trade at present is the settlement of contracts with the gas companies. Several of the companies are holding their hands in the hope of obtaining easier terms the longer they keep out of the market. Such contracts as are being settled show a reduction of 3d. to 6d. per ton on the rates which expire on June 30th. Coal for coke-making purposes is somewhat scarce, with an upward tendency in price.

In the iron trade a fair amount of buying is reported in pig iron. The prices continue weak, a drop of 6d. to 1s. per ton being reported in several of the brands, including Lincolnshire.

An improvement is reported in the finished iron trade throughout Sheffield district, and more employment is now being given. The chief complaint is about the lowness of prices. The profit, where it is obtained, is exceedingly small, while much is being turned out absolutely without a balance to the good. Several manufacturers state that a good deal of foreign steel is being used instead of iron, and that, but for these imports, the necessities of the trade would exceed the weight of pig iron to be obtained in the country.

Nothing has yet been heard about the Government orders for armour-plates under the new Admiralty programme. The work is very much wanted now, and, it is hoped, will not be long delayed. Orders for railway material are by no means plentiful, and what are being placed are evidently given out to meet pressing requirements. Marine material is also in very slight request, with no immediate prospect of any improvement, as the accounts from the shipbuilding yards are not encouraging.

A more cheerful feeling is evident in the steel industries. Buyers are said to be readily making arrangements for immediate and even future requirements. Several of the manufacturers are doing much better, and one or two contracts of consequence have been booked for delivery during the next half year. Values do not alter; in fact, there has been no change for nearly eighteen months, Bessemer billets having remained during that time at £6 15s. per ton, and Siemens billets at £7 5s. per ton. A feature of the steel trade is the improving business being done on Spanish account. The United States manufacturers find Sheffield competition more effective than formerly. The Spanish business is mainly with our South American colonists, and good hopes are entertained of a large increase in that trade. The demand for high-speed steels, which has been noticed from time to time, continues as important as ever, and very fair accounts indeed are given of the business doing both for home and foreign markets with tool steels of the higher grades.

In the lighter staple industries there is an improvement in several of the distant markets, more particularly in South Africa and Canada. The Australian market is slowly recovering from the effects of the drought, but it is doubtful if any great change for the better will take place this year.

The London, Birmingham, and Sheffield Silver, Electro-plate, and Britannia Metal Trades Affiliations held their annual conference in the Sheffield district on June 20th and 22nd. The opening meeting was at Eyam, where Mr. W. F. Hill, of Birmingham, president of the silver trade, read a paper on the "Labour Problem." The second meeting was held at Sheffield, where Mr. Humm, of London, read a paper on "Legislation by the People; its Possibilities for the Future." A resolution in favour of direct representation of the working classes in Parliament and on local bodies was passed. At a public meeting subsequently held, it was resolved to continue the organisation until all the branches were amalgamated into one union.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE iron market in this district continues steadily to become more favourable for the producers, confidence is being restored, and on the whole an encouraging report can fairly be given. Almost everything points to a run of improvement, and a sanguine tone is generally noticeable among both sellers and buyers of pig iron, and more particularly Cleveland pig iron. Makers have secured orders for large quantities during the last fortnight for delivery over the next half-year, consumers finding it advisable to buy freely for forward delivery, because there are indications that if they wait they will have to buy to less advantage than at present. Prospects are certainly more satisfactory now than of late, and there seems to be every reason to believe that the improvement that is reported is a genuine one, and is not due to speculative operations. As a matter of fact, there is little in the way of speculation now carried on; the stocks of Scotch and hematite pig iron are almost exhausted, and transactions in them are almost nil—in fact, they are two small to admit of speculators safely operating in them. Not much is being done in Cleveland warrants; in fact, business on the warrant market has not been so slow for some years as it has been this month, and the influence on the general market has only been slight.

The iron market at present is most influenced by the large shipments, and the substantial decline in the stock of pig iron in the public warrant stores. The sound and healthy position of Cleveland makers is apparent from the fact that though the demand from the United States has ceased trade here has been comparatively little affected, producers are delivering into other hands all the pig iron they make, and could find a market for more if it were forthcoming. Owing to the dearth of stock with makers it has been necessary this month to draw considerable quantities of Cleveland pig iron out of Connal's public warrant stores, so much so that the quantity on Wednesday was 136,517 tons, a decrease for one month of 6923 tons. This is a different showing from what has been reported for several weeks, and, in fact, months.

In regard to shipments of pig iron from the Cleveland district they have been extremely good this month, much in excess of those of June last year, in spite of the fact that America was then a good customer. The deliveries oversea have this month been double those of a year ago; to Scotland 37 per cent. more has been sent, and to various English ports 23 per cent. more. These facts have a great influence for good on the pig iron market generally, and confidence is more plainly shown. The total shipments of pig iron from the Cleveland district this month to Wednesday reached 87,183 tons, as against 79,804 tons last month, and 64,200 tons in June, 1902, to 24th. The stability of the position of the Cleveland pig iron makers is well illustrated by this fac,t that though they have no longer the custom of the American market they have not had to reduce their output, and have had no difficulty in finding markets for their iron elsewhere; indeed, just now they cannot satisfy all the demands made upon them, and consumers have frequently to complain of the delay in getting deliveries of iron due to them. Cleveland iron is certainly very scarce for prompt delivery, most of the makers having become denuded of stock.

Another feature which ironmasters regard with satisfaction is to be reported this week: the cost of production may be reduced, as the price of coke is tending downward. Coke has for a long time been relatively dearer than Cleveland pig iron, and still is so. This week the coke manufacturers have been pressing sales rather strongly, and have had to reduce prices 3d. per ton, the price for medium qualities delivered at the Teesside furnaces being put down to 16s. per ton. Thus while pig iron is improving in value the price of coke is becoming weaker. Pig iron makers are holding off from contracting much for next half-year, and prefer to buy supplies for early delivery.

Makers have this week raised the price of No. 3 Cleveland G.M.B. pig iron for early f.o.b. delivery to 46s. 9d. per ton, and second hands have not generally taken less; indeed they are not now underselling the producers. Consumers are anxious to buy for forward delivery, but sellers are in no great hurry, because they have good reason to believe that prices will improve. No. 1 has been raised to 49s., and No. 4 foundry is nominally at 46s. 6d., but it is difficult to find any one who is able to sell the latter. Forge iron is somewhat dearer, grey having been put up to 45s. 3d., and mottled to 44s. 9d., while white is at 44s. 3d. There is not much forge offering on the market, and the little there is can only be got from makers themselves, there being none lodged in the public warrant stores, and producers have very little in stock, less than they have had for years.

The hematite pig iron trade is not so strong as that of ordinary Cleveland iron, and steel manufacturers, owing to the depressed condition of shipping and shipbuilding, are not pressing to buy. A few inquiries are being received from America, but they are not for ordinary hematite—they are for special qualities of hematite. For mixed numbers of East Coast hematite pig iron the price is steady, with makers at 57s. per ton, though a little less was taken by second hands early in the week. No. 4 is at 53s. 6d. Rubio ore is not below 16s. per ton delivered at wharf on Tees or Tyne, but still it must be reported that there is a weaker tendency.

As a rule, the business in manufactured iron and steel has become quiet, and it is difficult to get orders, especially for the iron and steel employed at the shipyards. This and the competition of the Scotch producers have led the plate makers' combination to reduce the price of steel ship plates 5s. per ton, bringing them down to £5 15s., less 2½ per cent. f.o.t.; but the prices of iron ship plates and steel boiler plates have not been interfered with, the former being kept at £6 15s., and the latter at £7 5s., both less 2½ per cent. Steel ship angles are at £5 10s., and iron ship angles at £6 7s. 6d., both less 2½ per cent. Manufactured iron generally is stronger in price than steel. Common iron bars are firm at £6 10s., less 2½ per cent., and basic steel bars at £6 15s., less 2½ per cent., the demand for both being fairly satisfactory.

The activity in the steel rail trade is maintained, and prospects are looked upon as satisfactory. The official quotation for heavy steel rails is £5 10s. net at works. Cast iron railway chairs are at £3 15s. net, but that would be shaded if a considerable quantity were wanted.

The shipbuilding industry has slackened, scarcely an order coming to hand. Messrs. William Doxford and Sons, Limited, Sunderland, have secured an order for an improved turret-deck steamer of 6250 tons carrying capacity for Messrs. Wiel and Amundsen, of Frederickstadt, Norway. It may be stated that owing to extension of Messrs. Doxford's business, Sir William Doxford, who has been one of Sunderland's M.P.'s since 1895, intends to retire from the representation of the town at the next general election. The amalgamation of the business of Messrs. C. S. Swan and Hunter, Limited, Wallsend, and J. Wigham Richardson and Co., Limited, Walker, has been arranged, and this week the new company—Swan, Hunter, and Wigham Richardson, Limited — has offered to the public £300,000 of 4½ per cent. debenture stock, part of a total proposed issue of £500,000. The capital of the amalgamated concerns is £1,500,000. The company takes over certain shares in the Wallsend Slipway and Engineering Company, Limited. Mr. G. B. Hunter is chairman of the new company, and Mr. J. Wigham Richardson vice-chairman.

The report of the directors of Messrs. Head, Wrightson and Co, Limited, Teesdale Iron and Engineering Works, Stockton, will be regarded with satisfaction by the shareholders, for the payment of a larger dividend than was expected is announced. The last dividend was 5 per cent.; now 7 per cent. is to be paid, which is very favourable when people are looking rather for reduced than for increased dividends. The company has done well, for not only is the dividend larger, but out of the profits of the past year £10,000 has been taken for depreciation in respect of capital expenditure. The total amount of profit was £41,590, and there was £42,943 to divide. The expenditure on capital account during the year amounted to £40,773 10s. 2d., almost entirely arising from the installation of electrical driving power at the Teesdale Ironworks, and from this the directors expect a substantial economy in the cost of production.

The coal trade is in a generally favourable condition, and prospects are satisfactory, especially in the gas coal branch. The coalowners are well sold ahead, and they will not contract for forward delivery except at advanced prices. Some have put up the price to 9s. 3d. and others to 9s. 6d. per ton, and the minimum is now fully 9s., with 8s. 6d. for seconds. In steam coal the business is good, and 10s. 7½d. f.o.b. has to be paid for best qualities, with 9s. for seconds and 5s. 9d. for smalls. Coke is somewhat cheaper, 17s. 6d. f.o.b. being the figure for foundry and 16s. for medium, delivered at the blast furnaces on Teesside. Messrs. Bolckow, Vaughan and Co. are introducing electric motors very extensively at their Auckland Park, Binchester, and Westerton collieries, where the only steam used will be for the winding engines which bring the cages to bank. There will be no underground hauling engines, and electric motors will bring the "setts" of tubs outbye to the shaft, and electric machinery will work the coal washers, screens, &c.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

A SOMEWHAT more cheerful feeling has been noticeable this week in the Scotch iron trade. From several quarters there are indications coming that appear to warrant a more hopeful view of the future. The reductions in the Bank rate appear to have favourably affected speculative business in warrants for the moment, and the slump in metals has had less effect on pig iron than might have been expected.

The Glasgow warrant market opened quietly, but the tone considerably improved, and higher prices were obtained for Cleveland iron, which is much in demand, at the same time that stocks of all kinds of pigs are decreasing.

Scotch warrants have been quoted from 51s. 10½d. to 52s. 3d. cash, and 52s. 1½d. to 52s. 7½d. one month. Business has been done in Cleveland warrants from 46s. 5d. to 46s. 10d. cash, and 46s. 6d. to 47s. one month. Cumberland hematite is quoted 57s. 9½d. to 58s. cash, with very little business doing.

Scotch hematite pigs have been in steady demand for home use, and it is reported that there is still some prospect of this class of iron being wanted for export to the United States. Merchants quote Scotch hematite 61s. 6d. per ton for delivery in railway trucks at the West of Scotland steelworks.

The prices of Scotch makers' pig iron are steady.

Since the last report, one hematite furnace has been put out at Coltness Ironworks. There are now 81 furnaces in operation in Scotland, compared with 85 at this time last year, and of the total, 42 are making hematite, 33 ordinary, and 6 basic iron.

The shipments of pig iron from Scottish ports in the past week were small, amounting to only 4785 tons, and the arrivals of Middlesbrough pigs at Grangemouth were large, amounting to 14,060 tons.

During the first half of the year the United States have taken about 26,000 tons of Scotch pig iron, compared with 13,000 tons in the same period of 1902. The shipments to Canada are about 15,000 tons, against 5000 in the corresponding period. But for these two markets, our exports would probably have not shown any increase over those of last year.

The prospects of business are looking a little more encouraging in various branches of the manufactured iron and steel trades. There are a good many contracts in the market, both for home and foreign use. The construction of the buildings in connection with the new Government naval base on the Forth will almost immediately afford a large amount of work, some of which has already been placed with Scottish firms. Several extensive contracts for girder and roofing work in connection with other home enterprises have also just been arranged, while quite a number of municipal, railway, harbour, tramway, and other contracts are announced as coming forward. In the meantime, on the other hand, the shipbuilding industry continues dull, and there does not seem to be any early prospects of an improvement. The freight market is dull, the outlook for international trade is unsettled and uncertain, and the prices offered for the few shipbuilding and engineering contracts coming forward are comparatively poor.

There has been more doing in the coal trade in the past week. The preceding week's shipments had been indifferent, but there has since been a marked improvement. The aggregate clearances at the Scottish ports amounted to 246,327 tons, compared with 211,213 tons in the preceding week, and 231,050 tons in the corresponding week of last year. The current inquiries appear to indicate that export business may be fairly active in succeeding weeks. There is no change of importance in shipping prices. In the home branch of the trade there has been more doing than is usual at this season, household coals having been in steady demand, while there is a large industrial consumption.

Sheriff Jameson, the arbiter of the Scottish Coal Trade Conciliation Board, after hearing evidence, has decided that the coalmasters have made out their claim for a reduction of 3d. per day in the colliers' wages, which will now be reduced from 5s. 6d. to 5s. 3d. The reduction affects about 70,000 miners.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE announcement that the coal tax will be continued has not caused any comment of note, the consensus of opinion being that such would be the case.

Prices of the best steam have not been so firm of late, for which the tendency a week ago was to touch 15s.; sales have been made from 14s. 6d. to 14s. 9d., and these remain the latest quotations. Small, which has fluctuated, is now easy at 7s. 9d., inferior being obtainable from 6s. 6d., and good seconds up to 7s. 6d. This week the demand for Monmouthshire was well sustained, and as supplies were inadequate prices were firm, the very best touching 13s. 9d., and good ordinaries 13s. to 13s. 3d.

It is now a sight of rare interest to see the coal traffic, not

simply from pit to port, but also upon all the great lines from South Wales and Monmouthshire. This promises to make the holiday season now opening a busy one. I am glad to note that the Cambrian, Brecon, Cardiff, and Rhymney start new trains in July to meet this.

Some degree of interest was aroused on 'Change, Cardiff, a few days ago by the statement that a French syndicate was likely to attempt the purchase of several Welsh collieries—six or seven it was added. At present names of the collieries are not given, but the French company is represented in London by the Agence des Actionnaires Français à Londres. Considering the large shipments making to France from Cardiff and Swansea, the likelihood of such a step is regarded as probable.

The McLaren-Merthyr Coal Tredegar Company has been placed on the Admiralty list.

The appointment of Mr. Waddell as engineer of the Barry, which I announced last week, has been confirmed.

Several colliery changes have taken place. Mr. Bowen, of Pontlottyn, has left for Cyfarthfa, where he will be under colliery manager at the Castle pit, in place of Mr. Howells, who has left for Aberpengwrw, where Mr. Stuart Williams is carrying out an important colliery just outside the anthracite district. Mr. Picton, manager of the International Blaengarw, is leaving, and will be succeeded by Mr. Morgan, under manager of the Ocean Colliery.

Non-unionist troubles were the cause of the Universal Colliery being "on stop" Monday and Tuesday.

Little has been heard of late regarding the anthracite syndicate. Prospects are regarded as satisfactory independently of this, and a little later on in the malting season there is full expectation of a pressure for best, which now runs from 18s. to 19s. Second malting is at 17s, Big Vein at 13s. 3d., and a good large coal 10s. 6d. Cobbles fetch 18s. to 19s., nuts 21s., cubes 6s.

Labour troubles are "on" at the Aman Valley pit; at Llanelly the Llanon and Gwendraeth are busy. All that is wanted is the opening of the harbour to improve the coal trade and general industries.

Increased quantities of coke are being exported foreign, Rio taking a quantity. Port Said, Cronstadt, East London, Copenhagen, and Constantinople are figuring for large coal cargoes. From Cardiff coke prices are maintained, furnace from 17s. 6d. to 18s. and foundry 19s. 6d. to 25s. Patent fuel is in tolerable demand at all ports. Swansea total last week was not so great as of late. Competition is evidently keen in this industry. Swansea prices, including tax, are from 13s. 6d. to 14s.; Cardiff and Newport, 14s. 6d. to 15s. 3d. Pitwood quotations weak at 16s. 6d. to 16s. 9d. Some iron ore has come into Cardiff from Bayonne.

There is not much to note in connection with iron and steel. On 'Change, Swansea, this week it was stated that the pig iron market had been steady, with but slight change. The situation in America was the subject of comment, and the fear was expressed that we might have an inundation of make of the "overflow," but this, so far, is still in expectation. A more depressing fact discussed was the attitude of German makers, who have introduced steel bars here at 10s. per ton less than they can be made. Protected by the tariff this has told adversely, though, as pointed out in this column, the production of inferior plate made from German steel bar has not been a politic course for Welsh tin-plate makers to adopt, and in some quarters it has been abandoned. The best Welsh bars, Bessemer, are selling at £4 15s, Siemens at £4 17s. 6d.

Most steel quotations remain. Rails are at £5 5s. to £5 10s. heavy. This week a cargo of 700 tons left Cardiff for Natal. The rail industry is the most conspicuous feature now at the chief works, and in view of home demand, and Indian and South African requirements, hopeful.

The keenest attention is being paid to the make of steel rails and bars in all quarters, the most urgent need being required to keep down cost. One of the leading employers is reported to have said, "We do not conduct our works for philanthropic reasons, and when they cease to pay we close down." In the Llanelly district the new works of R. Thomas and Co. promise in equipment to be second to none. More steel furnaces are being started in the Swansea Valley. In tin-plate, with steel cokes at 11s. 9d. to 12s., and best Siemens up to 12s. 3d., the buyer has little or no cause to complain. Shipments last week were up to 70,000 boxes, but on account of a number of mills being idle at one time, as many as seventeen, make was limited to 54,000 boxes. Russia and America are in the market for supplies. Also the Far East.

The report of the directors of the Ebbw Vale Company is an interesting one, and cannot fail, I think, to give satisfaction as showing how, in the face of home rivalry and European competition, a determined and successful effort has been made to carry on the work. The chairman has shown that a profit has been earned during a period of very depressed trade in coal, iron, and steel, pointing out a disposable balance of profit amounting to £124,047 12s. 3d. This will be disposed of as follows:—£30,000 added to reserve account, £74,475 paid away in dividend (5 per cent.), and £19,572 12s. 3d. carried forward. The chairman referred to the fact, instanced repeatedly in this column, that a good deal of trouble had been caused by the rivalry of Belgium and Germany, a great bulk of the material imported coming to Newport, right amongst the best customers of the company. One of the shareholders, seconding the proposition of dividend, &c., stated that the additional profit made was largely due to better trade, and better management both of steel works and collieries.

An official inspection of the new docks at Bristol was made by the Corporation this week, and the progress voted to be satisfactory. The dock wall for about 5000ft. is in various stages of construction, three-quarters of a million cubic yards of earth have been excavated, the amount of reclamation from the sea is noteworthy, and also the good work done in construction of the piers. Sir Benjamin Baker and Mr. Ellis, the partner of Sir John Aird, were both present.

The piers of the new viaduct in the Caerphilly Valley, which is to connect the Barry Railway with the new coalfield of the district—the Rhondda of the future—are progressing well, but in all probability the colliery enterprise of this field will be shared by the other lines and by the port of Cardiff. With ample supplies and a tranquil labour market there will be abundant business for all.

The death of Mr. Fothergill took place this week at Tenby, where he had been long resident, ever since the unfortunate closing of the ironworks and collieries of Abernant and Plymouth. Amongst the old ironmasters he will be remembered for his zealous efforts in the production of hot blast and "steely iron" at the juncture when steel in Wales was coming into use instead of iron, and by the old coalowners for his advocacy in Parliament of the merits of Welsh steam coal. His services in Parliament, like those of Vivian, were valuable, but to John Nixon for practical advocacy of Welsh coal the highest merit is due, and to Lord Aberdare, Sir Geo. Elliott, and Sir W. T. Lewis, the palm for local and legislative enactments. Mr. Fothergill had passed his eightieth year.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE unfavourable accounts received from America have not been without influence on the condition of the general iron market over here. Silesian ironmasters state the trade done in the various departments to have been exceedingly moderate and irregular, demand showing, on the whole, a falling off against previous weeks. Merchant iron especially has been flat, and very few forward orders could be secured for home consumption. A good inquiry has been coming in on foreign account, both in girders and hoops, and a pretty lively occupation continues to be reported from the plate and sheet mills, which is, however, chiefly owing to the fairly brisk export trade that is being done. The Rhenish-Westphalian iron trade was tolerably active—at least in some branches a good employment could be noticed, but there are also many establishments that can only keep up a moderate occupation. Export to all other countries except to America has been strong upon the week; one Rhenish-Westphalian works sent 25,000 t. basic to Belgium, also white forge pig and foundry pig have been in good demand on foreign account. On the whole, the inland consumption in pig iron has been more extensive quite recently, and so the falling off in export is less keenly felt; the majority of the blast furnace works are well supplied with orders for some months ahead. Billets, blooms, and raw bars meet with strong request, and the manufactured iron business remains regularly employed; girders and plates are in active request and show a marked upward tendency. Wire, too, appears to improve, and employment at the construction shops increases. Mining plant is in very good call, and the shops engaged in the construction of mining machinery are actively occupied.

For the building of the large Krupp Works in Rheinhausen, to which reference has been made in a previous letter, about twenty-two million marks will be required. There are going to be erected three blast furnaces, an iron foundry, a large electricity works, a Siemens-Martin works, several rolling mills for rails, plates, and different articles of manufactured iron.

A pretty firm tone was maintained on the coal market in Rheinland-Westphalia and Silesia; especially for small coal a regular inquiry was experienced, and dealers in Rheinland-Westphalia have been purchasing freely. Shipments in engine coal have been increasing.

From the Austro-Hungarian iron market discouraging accounts are still coming in, pig iron being neglected and manufactured iron dull, as before. Even reduced quotations have not in any way improved the condition of the sheet trade, and the hardware industry likewise suffers from the abnormally weak state of the iron market. Prices for enamelled articles have lately met with a reduction of 2 and 3 per cent.

Both engine and house coal continue very dull in Austria-Hungary.

Business has been somewhat quiet this week on the Belgian iron market; only rails continue brisk. Recently, Belgian rail works lost a large rail order for Holland, which was given to a Rhenish-Westphalian works, the Belgian works quoting 50 centimes p.t. more; but there are further rail orders holding out for Denmark and other countries. The Belgian State Railways have ordered 102 locomotives, of which 77 have to be delivered at a price about 7 per cent. lower than that quoted at the last tenderings. For the remaining 25 locomotives a price has not yet been agreed upon.

Coal for industrial purposes has met with good demand in Belgium, and the business in briquettes is also brisk and improving. A stiff tone is noticeable in the coke trade, and a change in prices is not likely to take place for the present. House coal is very quiet.

Prices, generally, are well maintained on the French iron market, and the position is very much as last reported. Rails have been inclined to move upwards in the Ardennes, and the majority of the ironworks in the Haute Marne are well provided with contracts for some time ahead.

Inquiry for engine fuel in France remains active, with prices tending to firmness. House coal, on the other hand, is dull.

French general import, during the first five months of present year, is officially stated to have been worth 2,004,809,000f., against 1,892,898,000f. for the same period in the year before. Export was worth 1,746,086,000f., against 1,751,071,000f. for the corresponding period in 1902.

According to the *Weser Zeitung*, the Shipping Company Rickmers, of Bremen, intends increasing the number of their sailing vessels and steamers to about thirty in the course of the next three years. The ships are to be built in the dockyard of the company, at Bremerhaven, and will be chiefly used for the import of rice.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market firm for prompt shipment. Tonnage has come on better. House coal keeps in fair demand. The quantity of coal shipped for week ending June 20th was 77,486 tons—foreign, 55,750 tons; coastwise, 21,736 tons. Imports for week ending June 23rd: Iron ore, 8510 tons; loam, 635 tons; steel bars, &c., 4553 tons; deals, boards, &c., 5660 loads; pitwood, 1636 loads.

Coal: Best steam, 13s. to 13s. 3d.; seconds, 11s. 6d. to 11s. 9d.; house coal, best, 15s; dock screenings, 7s. 6d.; colliery small, 7s. 3d. to 7s. 6d. Pig iron: Scotch warrants, 52s. 6d.; hematite warrants, 57s. 9d., f.o.b. Cumberland prompt; Middlesbrough, No. 3, 46s. 9d. Iron ore: Rubio, 14s. 9d.; Tafna, 15s. 6d. Steel: Rails, heavy sections, £5 5s. to £5 10s.; light ditto, £6 5s. to £6 10s., f.o.b.; Bessemer steel tin-plate bars, £4 15s.; Siemens steel tin-plate bars, £4 17s. 6d., all delivered in the district, cash. Tin-plates: Bessemer steel, coke, 11s. 9d. to 12s.; Siemens, coke finish, 12s. to 12s. 3d. Pitwood: 16s. 3d. to 16s. 9d., ex ship. London Exchange telegrams: Copper, £55 17s. 6d. to £56; Straits tin, £126 10s. to £127. Freights steady.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, June 17th.

THE latest rumour is that if the Dominion Government should place duties on American steel products, that the United States Steel Corporation will erect steel plants across the border of sufficient magnitude to supply the Canadian demand. The present duties are not prohibitive, but any increase will probably be followed by measures that will secure the control of Canadian business to United States mills. The present price of steel rails, which is 28 dols. per ton, will be continued during next year, and it is quite probable that the greater portion of next year's capacity will be sold during the latter half of this year. Announcements of new railroad building enterprises, backed by abundant capital, continue to be made, and in the opinion of the very best transportation and financial authorities, railroad construction next year will exceed in mileage that of this year. The demand for structural material and plate, while on the surface quiet, is known to be heavy, as measured by capacity. Every plate and structural mill is sold far ahead, as was illustrated a few days ago by the effort of the Pennsylvania Company to obtain supplies this autumn for the construction of some new bridges in New Jersey. It is understood the company is obliged to go abroad for its material.

The situation throughout the steel industry is as satisfactory as could be desired. The only falling off in demand noticed is in connection with the building trades, and that is due to strikes, which prevail very generally. An early resumption of work is expected and lost time will be made up. There is a stronger demand this week than last for all kinds of pig iron. Steel billets are still held firmly, although it is understood that where exceptionally large quantities are contracted for that moderate concessions can be had. No. 1 X foundry is selling here at from 20 dols. to 21 dols.; No. 2 X foundry is 19 dols. to 20 dols., and grey forge at 19 dols.; Southern foundry can be had at about 50 cents per ton less; girder rails are in active demand at mill at 33 dols. Structural material at 1.75 dols. per pound. Bessemer steel at Pittsburg, 30.50 dols.; old iron rails, 25 dols.; old steel rails, 21 dols. Railroad earnings are large and most satisfactory, and it is to this fact that much railroad building enterprise is to be credited. During the month of May the gain in gross earnings on half of the mileage of the United States amounted to nearly 12 per cent. over same month last year. The industries generally are crowded with work. Merchandise shipments are crowding railroad capacity; the shortage of cars continues to be a subject of complaint in many sections of the country. The copper market is unsettled, and home trade is rather light at present, with only a moderate demand for export. The shrinkage in exports of copper for the first five months of the year amount to 26,000 tons, and so far in June the shipments have been 3600 tons compared with 5800 tons for same time last year. The pig tin market is very quiet this week, as present requirements are sufficiently well covered. Closing quotations 28 25 dols., being 25 points above the lowest during the past week. In pig lead, Western floods have restricted shipments, and there has been consequently an increased demand for spot stock. The market closed steady at 4.375 dols. In view of the steady downward trend of the market abroad, lower prices had been expected here, but the unexpected floods arrested the downward tendency. Stocks of spelter are extremely light; business at St. Louis is at a standstill. Quotations are 5.50 dols. spot; quicksilver has been in very good demand on a basis of 47.50 dols. per flask. The outlook for metals is favourable to mining and jobbing interests, as the stocks in this city are of moderate dimensions, and consumers generally are not loaded up. The floods are subsiding, and shipments will be renewed in a short time. A good deal of new territory that will produce lead and zinc is being opened up, and the market can rely upon a sufficient, if not an abundant, supply for the future.

TRADE AND BUSINESS ANNOUNCEMENTS.

THE British Steam Specialities, Limited, ask us to state that they have opened London offices at 73, Farringdon-road.

ERNEST SCOTT AND MOUNTAIN, Limited, inform us that they have removed their London branch-office to Norfolk House, Laurence Pountney-hill, London, E.C.

THE gold medal offered by the Wirrall and Birkenhead Agricultural Society for the best engine for agricultural purposes, competition open to the United Kingdom, was won by the "Blackstone" oil engine.

BUCK AND HICKMAN, Limited, have opened an office in Glasgow — Atlantic-chambers, 45, Hope-street—and are now represented there by Mr. John H. Davey, late of the Brown and Sharpe Manufacturing Company.

THE BROOKE TOOL MANUFACTURING COMPANY, Limited, Belgrave-road, Birmingham. This company has been registered with a capital of £4000 in £1 shares—2500 preference—to acquire the business carried on at 179, Belgrave-road, Birmingham, as the Brooke Tool and Stamping Company.

MESSRS. FRANCIS MORTON AND CO., Limited, have appointed Mr. O. J. Wendlandt their representative for Sheffield and district, including Yorkshire, Lincolnshire, Nottinghamshire, and Derbyshire, in place of Mr. L. Marshall. New offices have been secured in the New Corporation-buildings, Angel-street, Sheffield.

PINTSCH'S PATENT LIGHTING COMPANY, Limited, have made arrangements with the entire Pennsylvania Railroad system to supply it with Pintsch gas, and has under construction gas plants at Philadelphia, Harrisburg, Altoona, and Pittsburg, and expects to have these plants in operation in about three months. About 4500 passenger cars will be supplied by the gas plants above mentioned and the present plants at Jersey City, Camden, Buffalo, Columbus, Cincinnati, Chicago, and St. Louis.

THE order has been placed by the London County Council with Messrs. Forrestt and Son, Limited, Wyvenoe, Essex, for a twin-screw fire float for service on the river Thames. The vessel will be of the tunnel type, the dimensions being 99ft. by 16ft. by 5ft. The machinery will be supplied by A. G. Mumford, of Colchester; and Mumford's water-tube boilers will be fitted. Two sets of powerful steam pumps, to be supplied by the Council, will be fitted on board by the builders. The vessel will be fitted throughout with electric light.

IN 1846 Mr. D. Y. Stewart and Mr. Howard Bowser, with others, commenced business as cast iron pipe manufacturers. In course of time the business was taken over by Mr. Bowser and his son, Mr. Charles H. Bowser, in 1896. Owing to the decease of Mr. Howard Bowser in 1899, an arrangement with his family has been effected, and the business, 80, Charles-street, St. Rollox, Glasgow, has now been registered as a private limited liability company, under the continued management of Mr. Charles Howard Bowser, who joined the business in 1891, and Mr. Frederick William Arthur.

MULE haulage is to be replaced by electric traction on the De Beers Mines, an order having just been placed with the British Westinghouse Electric and Manufacturing Company, Limited, for the supply of twelve mining locomotives of the Westinghouse 4 2/10 C type, with the requisite spare parts, &c. These locomotives have four wheels, each pair driven by a Westinghouse motor of 10 horse-power capacity at a conservative rating. They can thus develop a full-load draw-bar pull of about 900 lb., running at six to ten miles per hour on the level. The most interesting features of these tractors is that, the guage being very narrow—18in.—the motors have to be mounted clear of the wheels. The motor pinion meshes in the ordinary way, with an additional intermediate gear wheel. The journals of the shaft carrying this gear wheel run in boxes working in pedestals over the main journal boxes of the locomotives, and rigidly connected to them. Thus the locomotive frame, which is supported on springs in the usual manner, is free to rise and fall on the axles without disengaging the gears. The motors are hung on the shafts of the intermediate gear as if these were the ordinary wheel axles, and the usual "nose" suspension is employed. These locomotives are built to last, both mechanical and electrical parts being of very strong, workmanlike construction.

INTERNATIONAL CONGRESS OF HYGIENE AND DEMOGRAPHY.—We are requested to state that full particulars of the eleventh International Congress of Hygiene and Demography, to be held in Brussels from September 2nd to 8th, 1903, with the travelling and hotel arrangements, may be obtained from Dr. Paul F. Moline, hon. sec. British Committee, 42, Walton-street, Chelsea, S.W.

CROMPTON AND CO., CHELMSFORD.—A large party of ladies and gentlemen were last Saturday invited by Messrs. Crompton and Company, of Chelmsford, to pay a visit to the Arc Works. Special saloons were provided by the firm on the 10.55 Great Eastern train, and the visitors, after being conducted over the whole of the works, which now employ over 1000 hands, were entertained at luncheon in the new recreation building recently erected for the benefit of the employés. After lunch the visitors were driven to the recreation ground, and spent a pleasant afternoon at the annual athletic sports of the firm.

THE MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.—The following paragraphs are taken from the report of the Committee of the Manchester Section of the Institute of Electrical Engineers for the third session:—Nine ordinary general meetings have been held. These meetings were well attended, there being an average of 118 members and visitors present. Your Committee have to report that no definite steps have yet been taken with regard to the Central Institution for the scientific societies of Manchester, but the matter is still under consideration by the Joint Committee. The second annual dinner was held at the Grand Hotel, on Friday, March 6th, and proved most successful, over 100 members and visitors being present. The number of members of this section are as follows:—75 members, 127 associate members, 188 associates, 82 students, total 472. Total last year, 415. The Committee have again to express their appreciation of the kindness of the Council of the Owens College and Dr. Schuster, in allowing the meetings of this section to be held in the new physical laboratory.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

10th June, 1903.

13,016. KNAPSACK, J. R. Jacobs, London.
13,017. CAR BRAKES, J. Runnoe, Kingston-on-Thames.
13,018. FOOD for CATTLE, H. H. Smith and H. S. Adey, London.
13,019. HOE, F. A. Frechsler, London.
13,020. SPARKING PLUGS, W. Sander, London.
13,021. NAVIGABLE VESSELS for CANALS, W. McLellan, London.
13,022. PACKING CONDENSER TUBES, T. H. Smith, London.
13,023. TRANSLUCENT DISCS, R. Lasky and L. Zweig, London.
13,024. APPARATUS for ADVERTISING PURPOSES, F. Judge, London.
13,025. MACHINES for CODING MESSAGES, J. S. Beeman, London.
13,026. MACHINES for SHAPING GLASS ARTICLES, H. H. Lake.—(*The Toledo Glass Company, United States.*)
13,027. RHEOSTATS, E. Weston, London.
13,028. INVERTED INCANDESCENT LAMPS, T. B. and T. E. Smith, Birmingham.
13,029. COUPLING BAR for TRAMCARS, C. Porter London.
13,030. SEPARATING PAPER in MACHINES, F. W. Vickery. London.
13,031. ELECTRODES for ARC LIGHTS, F. J. Gerard, London.
13,032. OBTAINING MOTIVE POWER, S. Schevzoff and M Zwerkoff. London.
13,033. PROTECTION of METALLIC SURFACES, B Glinsky, London.
13,034. SEPARATING PARTICLES from GASES, E. Theisen, London.
13,035. MAKING BLACK SULPHURISED DYESTUFF, O. Imray.—(*The Society of Chemical Industry in Basle, Switzerland.*)
13,036. TUG BOATS, T. N. Ceressy-Koressios, London.
13,037. ELASTIC TIRES, H. Sandwith, London.
13,038. TESTING ARMATURE COILS, Johnson and Phillips, and A. F. Galpin, London.
13,039. PUNCTURE-PROOF TIRES, G. M. Wolmershausen, London.
13,040. DEVELOPING PHOTOGRAPHIC PLATES, H. Knuckelkorn and E. Saupe, London.
13,041. NEW GAME, J. W. Colvin, London.
13,042. MATCH BOX, E. Rogers, London.
13,043. TAPS, L. Morin, London.
13,044. GASOLINE ENGINES, Vickers, Sons and Maxim, Limited, and J. McKechnie, London.
13,045. SAND BLAST MACHINES, C. A. P. Hess, London.
13,046. CERAMIC ARTICLES, J. Dansette, London.
13,047. TREATING COKE, E. S Beaven, London.
13,048. TURBINES, R. Haddan.—(*The Bergmann-Elektricitäts-Werke, Germany.*)
13,049. CALENDARS and DATE RECKONERS, L. Willmott, London.
13,050. SHIRT, F. J. Avery, London.
13,051. INKSTAND, L. Gutersohn, Berlin.

11th June, 1903.

13,052. DAVITS for LAUNCHING SHIPS' BOATS, J. S. Wilson, Westoe, South Shields.
13,053. STEAM GENERATORS, J. Y. Moyes, jun., Glasgow.
13,054. FIXING TIPS to BILLIARD CUES, J. A. Haase, C. Cox, and M. Welch Southsea.
13,055. SIGNALLING KEY for WAVE TELEGRAPHY, H. T. Ellis, Scalby, R.S.O., Yorks.
13,056. BOILERS, A. W. Metcalfe and J. S. D. Shanks, Belfast.
13,057. BATH WATER SYSTEMS, H. C. and A. A. Webb, Birmingham.
13,058. STEAM GENERATORS, D. Crowther, Leeds.
13,059. TELEPHONE SYSTEMS, D. L. Connal and D. B. Selkirk, Glasgow.
13,060. ALARM GUNS, A. E. Mitton, R. Whitehouse, and E. Blakemore, Birmingham.
13,061. FUSE HEAD for ELECTRIC BLASTING, F. Render, Manchester.
13,062. DENTISTS' ADVERTISING MEANS, J. Sim, Liverpool.
13,063. MEANS for REFRIGERATING LIQUIDS, J. Morton, Glasgow.
13,064. FORMING CHOCOLATE DROPS, R. Fleming, Liverpool.
13,065. WASHING MACHINES, W. L. Bradford, Manchester.
13,066. SEWING MACHINES, J. Hargreaves. Manchester.
13,067. COLLIERY TRAM COUPLING, H. Shipton and W. Cridland, Troedyrhiw, Glam.
13,068. LOOMS for WEAVING CARPETS, H. Wyman, Huddersfield.
13,069. CENTRIFUGAL MACHINES, J. W. Macfarlane, Glasgow.
13,070. BRANCH PIPE HOLDER STAND, J. G. Hodgson, Glossop.
13,071. ARMOUR-PIERCING LYDDITE SHELL, P. J. Pedney, London.
13,072. PACKING for PISTON-RODS, W. Harbinger, South Shields.
13,073. TILTING PICKING SCREEN, J. H. and E. Netherton, Trefriw, R.S.O., Carnarvonshire
13,074. SHOCKING MACHINES, H. J. Heinze, London.
13,075. MECHANICAL AIRSHIP, G. Clout, Worthing.
13,076. DUST-EXTRACTING APPLIANCE, J. A. Kennedy, Glasgow.
13,077. GARMENT STRETCHER, W. Cardno, Cambuslang, near Glasgow.
13,078. COLLECTING DUST from AIR, J. S. Anderson, Manchester.
13,079. PORTABLE BARRICADE, D. Hunter and S. Smith, Edinburgh.
13,080. SECURING COMBS in the HAIR, A. B. Keill, Dundee.
13,081. VENDING MACHINE, W. Fairweather.—(*F. C. Hutchinson, United States.*)
13,082. RUPTURE APPLIANCE, M. J. Lees, Preston.
13,083. NON-REFILLABLE BOTTLES, T. S. Heptinstall, London.
13,084. BEARINGS of WEIGHING MACHINES, T. Crossley, Blackburn.
13,085. STORING HOT GASES, P. B. W. Kershaw, London.
13,086. STAND PIPES for FIREPLACES, R. Phillips, London.
13,087. WATER-CLOSET SEATS, T. G. Rhodes and R. Haunt. London.
13,088. TIME RECORDERS, P. MacMaster and J. Duncan, London.
13,089. DEVICE for SUPPORTING PICTURES, T. C. Carter, London.
13,090. WASHERS for FIXING SOFT METALS, J. Stewart, London.
13,091. CLIPS for NECKTIES, J. Montgomery, London.
13,092. SANDAL SOLE FASTENING, H. F. Horrocks, London.
13,093. KNIFE-GRINDING MACHINES, A. J. Maffuniades, London.
13,094 SEWING MACHINE for HAIRY MATERIAL, A. Lucas, London.
13,095. DAMP-PROOF BACKING for TILES, J. G. Stidder, London.
13,096. FILM WASHERS for PHOTOGRAPHS, W. Taylor, London.
13,097. HYGIENICAL APPARATUS, R. Otto, London.
13,098. MERCURY CURRENT INTERRUPTERS, R. Otto, London.
13,099. HYGIENICAL APPARATUS, R. Otto, London.
13,100. ELECTRICAL CUT-OUTS, H. Korten, London.
13,101. RAILS for TRAMWAYS, J. Day, Wolverhampton.
13,102. MAKING PIGMENTS, W. J. Armbruster and J. Morton, London.
13,103. FASTENINGS for LEGGINGS, C. W. and H. S. Wycherley, London.
13,104. FASTENINGS for TIRES, R. M. Connable, London.
13,105. FASTENINGS for TIRES, R. M. Connable, London.
13,106. LOCKS, V. I Feeny, London.
13,107. STEAM INDICATOR for GENERATORS, I. Solovieff, London.
13,108. APPARATUS for CHARGING GAS RETORT, M. Graham, Apperley Bridge, Yorks.
13,109. AUTOMATIC TELEGRAPH PERFORATORS, J. Gell, London.
13,110. FINISHING the NECKS of BOTTLES, R. W. Orrock, London.
13,111. SANITARY CART, W. L. van R. Denton and W. N. Rezelle, Thornton Heath.
13,112. DRESS FASTENER, F. W. Margetts and W. L. Mitchell, London.
13,113. DRYING PRINTED PAPERS, H. W. Sanderson, London.
13,114. FINGER NAIL POLISHING DEVICE, H. H. Lake.—(*J. Leiter, Austria.*)
13,115. PARQUET FLOORING, H. H. Lake.—(*U. Spangher, Italy.*)
13,116. PRINTING FABRICS with INDIGO, O. Imray.—(*Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
13,117. LEAD LIGHTS for WINDOWS, J. A. Campbell, London.
13,118. DOUBLE PISTON PUMP, A. Rieter, London.
13,119. CARBONATE of SODA, W. P. Thompson.—(*Saron Frères and Cie, France.*)
13,120. PREVENTING THEFT of WATCHES, J. Bateman, London.
13,121. RULER, F. Pegler, London.
13,122. CANDLESTICKS, W. Nicol and J. H. Stewart, London.
13,123. TOBACCO PIPES, H. Williamson and The Williamson Patent Pipe Company, Limited, London.
13,124. FIXING HANDLE BAR STEMS to STEERING FORK STEMS, Rudge-Whitworth, Limited, and J. V. Pugh, London.
13,125. ATTACHING PARTS of MACHINES to their AXLES, Rudge-Whitworth, Limited, and J. V. Pugh, London.
13,126. UPWARDLY-ACTING FILTERS, J. Howard, London.
13,127. SPLIT COLLARS for SHAFTS, J. Y. Johnson.—(*R. W. Scott and L. N. D. Williams, United States.*)
13,128. HANGING HALL SET for CAPS, G. F. Kelt, London.
13,129. STEEL UMBRELLA STICKS, C. H. White and E. Newman, London.
13,130. SURFACE CONDENSERS, W. H. and R. W. Allen, London.
13,131. ATTACHING LUGGAGE CARRIERS to CYCLES, A. E. Hall and H. de M. Wellborne, London.
13,132. FIXING APRONS to VEHICLES, V. Drollon, London.
13,133. NUMBERING MACHINE, A. J. Boult.—(*Troy Laundry Machinery Company, Limited, United States.*)
13,134. LAUNDRY MACHINES, W. Bennett, London.
13,135. FISHING REEL, E. M. Funk, London.
13,136. PONCHO HOLDER, J. H. Tabler, London.
13,137. BREECH-LOADING ORDNANCE, V. C. Tasker, London.
13,138. CARBURETTER for EXPLOSION MOTORS, J. H. Johnston, London.
13,139. TILLS, H. C. W. Beeching, London.
13,140. STOPPERS for BOTTLES and JARS, W. H. Hilde, London.
13,141. RACKS for DISPLAYING ARTICLES, W. J. Chant, London.

12th June, 1903.

13,142. SUPPLYING CUT FLOWERS with WATER, B. R. F. Adams, Southwold, Suffolk.
13,143. PARAFFIN LAMP BURNERS, F. Sherwood, Birmingham.
13,144. PRESSURE-REDUCING VALVES, C. J. Atkinson, Marple, Cheshire.
13,145. MEANS for CONTROLLING RESTIVE HORSES by BLINDFOLDING, B. S. Weston and H. S. Wilton, London.
13,146. THE LEVER MOTOR, W. E. Fellowes Bradford.
13,147. LOOMS for WEAVING, L. Sutcliffe, Nelson, Lancs.
13,148. STRAINER for VESSELS used in MILKING, L. M. Burke, Dublin.
13,149. COMBINED LETTER and ENVELOPE, T. H R. Craig, Dublin.
13,150. GAS MIXER and MEASURING DEVICE, J. H. Ross, Birmingham.
13,151. WAGON WHEELS, The Boardite Company, Limited and S. G. Board, Manchester.
13,152. CONSTRUCTION of GATES, W. Peel, Burnley.
13,153. SHADE HOLDERS for ELECTRIC LAMPS, G. Chisholme Birmingham.
13,154. ROPE PULLEYS, T. Tomlinson, Newcastle-on-Tyne.
13,155. COUPLINGS for COLLIERY TRAMS, T. Evans, Cardiff.
13,156. MAKING HEXAGON NUTS, Bayliss, Jones, and Bayliss, Limited, and R. Howarth, Wolverhampton.
13,157. FIRE-ESCAPES, G. Grayson. Liverpool.
13,158. DOLMAN SHACKLE, D. Dolman and W. R. Ward, Barry Dock, South Wales.
13,159. LAVATORIES, M. J. Adams, Scotswood-on-Tyne.
13,160. URINALS, M. J. Adams, Scotswood-on-Tyne.
13,161. MULTIPLE CLOSETS, M. J. Adams, Scotswood-on-Tyne.
13,162. HOISTING GEAR, H. Wharton, Birmingham.
13,163. LOCOMOTIVE CRANK AXLES, W. and G. W. Drummond, Glasgow.
13,164. PAINT BUCKETS, J. E. Lucas, Glasgow.
13,165. SCARFING METAL PLATE EDGES, S. Smillie and T. M. Robertson, Glasgow.
13,166. FERRULES for WALKING STICKS, A. Miesch, Birmingham.
13,167. RAILWAY WAGON BRAKE MECHANISM, J. H. Reynolds, Mene, Wilts.
13,168. WATER-CLOSETS, G. Norman and C. E. Hall, Sheffield.
13,169. FORK SHACKLING for TRAMS, W. K. Lee, Aberaman, Aberdare.
13,170. PLANT POTS, G. W. Haworth and R. Baldwin, Manchester.
13,171. SUPPORTING a MARINE TORCH and LIFE-BUOY, A. F. J. Johnson, London.
13,172. BOOTS, &c., C. W. Prince, London.
13,173. CIGAR LABELS, P. A. Rubens, London.
13,174. VARIABLE SPEED GEAR for MOTOR VEHICLES, S. F. Edge and De Dion Dunlop Motor Company, Limited, London.
13,175. PULLING-OVER MACHINES, A. Bates and The British United Shoe Machinery Company, Limited, London.
13,176. ELECTRIC VEHICLES, G. Gibbs and H. Pearson, London.
13,177. CLAY-WORKING MACHINERY, Sutcliffe, Speakman and Co., Limited. and T. Dawber, London.
13,178. REMOVING PAINT from WOOD, E D. de Liebhaber, Wembley Hill, Middlesex.
13,179. ATTACHING DRAW-OFF TAPS to DRUMS, A. M. S. Watts, London.
13,180. CYCLE CHAIN CLEANER, A. J. Smith, London.
13,181. PLATEN PRINTING PRESSES, W. M. Rockstroh, London.
13,182. PLATING of METALS, F. W. Croucher, Fleet, Hants.
13,183. VEHICLE BRAKE HANDLES, F. J. N. Crofton, London.
13,184. SHEEP SHEAR REGULATORS, A. Taylor, London.
13,185. MANUFACTURE of PITCH, C. G. von Wirkner, London.
13,186. GAME MECHANISM, J. H Matthews, London.
13,187. MECHANISM for CUTTING BACON, G. Edwards, London.
13,188. HARVESTING MACHINES, C. Lauritzen, London.
13,189. FRICTION GEARING, R. O. P. Berglund and B. O. W. Hesselman, London.
13,190. OPERATING ELECTRIC BELLS, F. C. Morris, London.
13,191. LUBRICATING SPINDLES, J. Thompson, J. J. Orrell and W. Mee, London.
13,192. MAKING NEW DYESTUFFS, H. E. Newton.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
13,193. MOULD for BUILDING BLOCKS, A. M. Lambert, London.
13,194. ROOFING TILE, A. M. Lambert, London.
13,195. COIN-FREED GAME, A. Browne.—(*E. S. Gregory, United States.*)
13,196. VENETIAN BLINDS, W. E. Knight, London.
13,197. METAL BOXES, Hudson, Scott and Sons, Limited, and E J. Baber, London.
13,198. HERMETICALLY SEALED RECEPTACLES, J. F. Markes.—(*T. A. Wethered, Teneriffe.*)
13,199. ELASTIC FLUID HEAT ENGINES, S. Z. de Ferranti, London.
13,200. NON-REFILLABLE BOTTLE, G. M. Anderson, London.
13,201. MEANS for EXCLUDING SOUND, H. N. Baxter, London.
13,202. REVIVIFYING GAS PURIFIER WASTE, P. Jensen.—(*F. Hiorth, Norway.*)
13,203. SUSPENDER for TROUSERS, &c., J. T. Gradon, London.
13,204. BOTTLE, C. W. Johnson, London.
13,205. PORTABLE EXCRETA PAILS, &c., H. Franken, London.
13,206. PRODUCING GASES from HYDROCARBONS, F. Jas, London.
13,207. BOOKCASES, L. E. A. Casadesus, London.
13,208. WRITING APPARATUS, C. J. F. Lange, London.
13,209. IRRIGATORS, C. Brieger, London.
13,210. CONTROLLING the DISCHARGE of SEWAGE, J. Graham, London.
13,211. SPILE for CASKS, E. S. Dix, London.
13,212. NAIL-CUTTING APPARATUS, E. Kaufmann, London.
13,213. COUPLING for RAILWAY VEHICLES, W. R. S. Jones, London.
13,214. ADJUSTABLE CRANKS, W. S. Boult, London.
13,215. CAR FENDERS, G. E. Wright. London.
13,216. FLEXIBLE LADDERS, W. A. Ehrmanntraut London.
13,217. SEVERING METAL BARS, W. B. Pearson and C. E. Roberts, London.
13,218. INSTRUMENTS for LEVELLING, D. N. Allard, London.
13,219. HARNESS SNAPS, W. P. Moffow, J. and H. L. Thomas, London.
13,220. PIPE JOINTS, T. W. Barber and A. E. Dobbs, London.
13,221. MAGNETO SEMAPHONE MECHANISM, The Magneto Electric Company, London.
13,222. APPARATUS for the PURIFICATION of GAS, F. Jas, London.
13,223. SHAFT COUPLING, J. Y. Johnson.—(*R. W. Scott and L. N. D. Williams, United States.*)
13,224. MIXING LIQUIDS and GASES, R. F. Wood-Smith, London.
13,225. GAS COOKING APPARATUS, J. Harper and Co., Limited, and C. Retallack, London.
13,226. ENCLOSED ELECTRIC ARC LAMPS, T. Hamilton-Adams, London.
13,227. AUTOMATIC VACUUM BRAKES, H. E. Brown, London.
13,228. PNEUMATIC TIRES, G. H. Ross, London.
13,229. MAKING SHEETS from LEATHER SCRAP, P. Belle, London.
13,230. SPANNER, F. D. S. Mitchell, London.
13,231. LOCKING DOORS SIMULTANEOUSLY, F. Laming, London.

13th June, 1903.

13,232. SUPPLYING CLEAN TOWELS, W. Garlick and A. J. Jackson, Manchester.
13,233. MANUAL DRAUGHT CARRIAGES, J. W. Pickstone, Manchester.
13,234. PICKER-UP for GOLF BALLS, E. B. Tym, Burnham, Somerset.
13,235. TREATING FIREWOOD with RESIN, J. and L. Hartley, Burnley.
13,236. TRIMMING WALL DECORATION EDGES, J. Oates, Halifax.
13,237. MILKING APPARATUS, W. H. Lawrence and R. Kennedy, Glasgow.
13,238. HAIR GRIP, L. Devosse.—(*L. Bussy and G. Guiguet, France.*)
13,239. FURNACES, J. Smith and T. McIlraith, Glasgow.
13,240. BOOT TREES, A. J. Thackray and W. H. Clowes, Birmingham.
13,241. DIFFERENTIAL SPEED DRIVING GEAR, J. Sikes, Birmingham.
13,242. STEAM TRAPS, W. Thomas, Manchester.
13,243. VENTILATING ELECTRIC TRAMCARS, G. H. Pinder, Manchester.
13,244. LIFT SUSPENDER, D. J. Michael, Swansea.
13,245. REMOVING WORKING BARRELS of DEEP WELL PUMPS, E. L. and F. A. Matthews, Pendleton, Manchester.
13,246. RUGS, G. O'C. Holloway, Birmingham.
13,247. ATTACHMENT for CIRCULAR KNITTING MACHINES, O. Tabberer and Pool, Lorrimer and Tabberer, Leicester.
13,248. CYCLE LOCK, G. M. and M. Nelson, London.
13,249. LATCH CASES, H. Vaughan and A. L. Caron, Wolverhampton.
13,250. SAFETY GUARD for TRAM-CARS, J. Cross, Halifax.
13,251. SASH and CASE WINDOWS, J. C. Hay, Edinburgh.
13,252. PASSENGER SEATS for MOTOR CYCLES, J. Mills and W. H. Fulford, Coventry.
13,253. GLOVE FASTENINGS, W. Adams, Birmingham.
13,254. CYCLE BRAKE MECHANISM, T. S. Smith, Birmingham.
13,255. KEYS and SPANNERS for CYCLES, H. Rudge, St. Helens.
13,256. DRILLS for COAL and ROCK, C. Walton, Sheffield.
13,257. HOLDING DEVICE for DRILLS, W. Blears, Sheffield.
13,258. POCKET CARD FILLING DEVICE, F. W. Lanchester, Birmingham.
13,259. BRUSHES, G. Hodge, Liverpool.
13,260. FUSIBLE PLUGS for STEAM BOILERS, W. H. and A. J. Bailey, Manchester.
13,261. INTERMEDIATE and ROVING FRAMES, W. H. Rhodes, Manchester.
13,262. ROTARY ENGINES, J. Hall and F. Staley, London.
13,263. MEDICINAL COMPOUND, R. Ambrose, Glasgow.
13,264. FIRE-BOXES for LOCOMOTIVE BOILERS, A. Trevithick, Glasgow.
13,265. NON-REFILLABLE BOTTLES, F. Bennett, Hastings.
13,266. ANTIVIBRATORY BALL HEAD for BICYCLES, J. Gorst, Chester.
13,267. BEARINGS, T. Firth, London.
13,268. FILE-CUTTING MACHINES, A. J. Boult.—(*M. Merk, United States.*)
13,269. MUSICAL INSTRUMENTS, P. Wuest, jun., London.
13,270. ADJUSTABLE SPOOLS for MUSIC SHEETS, P. Wurst, jun., London.
13,271. SEPARATING METALLIC ORES from GANGUE, A. E Cattermole. London.
13,272. LABEL AFFIXERS, G E. Howard, London.
13,273. METALLIC ROOFING PLATES, H. C. Ferron, London.
13,274. SECURING TRAILERS to CYCLES, T. Messenger, London.
13,275. ROLLS for GLOSSING ARTICLES, T. and C. W. Hall, London.
13,276. OUTDOOR SEATS, C. A. and H Bond, London.
13,277. GOLF BALLS, R. Raffety, London.
13,278. ELECTRIC ALARM APPARATUS, J. Werner and J. Olsen, London.
13,279. REMOVING OIL from STEAM, C. Kiesselbach, London.
13,280. SPEED INDICATOR, R. Jones and D. D. Esson, London.
13,281. DEVICE for TELEPHONE RECEIVERS, J. Capell, London.
13,282. COUPLING for ELECTRIC MOTORS, C. Wüst-Kunz, London.
13,283. GEAR for HOISTS, C. Wüst-Kunz, London.
13,284. SECURING the WINGS of WINDOWS, W. Witkugel, London.
13,285. MEANS for PRESERVING FURS, V. Honour, London.
13,286. TIRES for MOTOR CARS, T. and O. J. Meacock, London.
13,287. POWER-DRIVEN VEHICLES, G. R. Boulding, London.
13,288. BURNERS for OIL and SPIRIT LAMPS, J. Hinks and Son, Limited and H. D. Hinks, London.
13,289. FIRE GRATES, G. G. Brodie and J. D. Prior, London.
13,290. MANUFACTURE of SOLID CORDS, W. H. L. Alfrod, London.
13,291. HYDROCARBON BURNER for STOVES, W. P. Warren, London.
13,292. CHANNEL FLAP-LAYING MACHINES, J. B. Hadaway, London.
13,293. NON-REFILLABLE BOTTLES, F. McLeod, London.
13,294. PUMPS and STEAM ENGINES, W. T. Ekholm, London.
13,295. IMPROVED INCANDESCENT BURNERS, C. E. Baron, London.
13,296. PUNCHING MACHINES, A. Nicolas and J. Clipfel, London.
13,297. RECIPROCATING PUMPS, A. Wache, London.
13,298. MANUFACTURE of WHITE PAINT, R. Scholz, Cologne, Germany.
13,299. MEANS for PROPELLING BOATS, H. N. Farris, London.
13,300. LIGHTING of BINNACLE TOPS, T. S. Angus, London.
13,301. MANUFACTURE of ACETYLENE GAS, A. Ross, Liverpool.
13,302. PRESERVATIVES for MILKS, W. C. E. Simcocks, Liverpool.
13,303. PNEUMATIC TIRES, R. Teaffe, Liverpool.
13,304. MEANS for LUBRICATING HINGES, S. Münchausen, Liverpool.
13,305. BRUSH BOXES for DYNAMOS and MOTORS, W. H. Allen, Son, and Co., Limited, and C. C. Hawkins, London.
13,306. MANUFACTURE of INDIA-RUBBER SUBSTITUTES, The Velvril Company, Limited, and J. S. Howkins, London.
13,307. PLATES for FEED GRINDERS, G. C. Marks.—(*J. Muir and C. H. Herod, Canada.*)
13,308. FILLING HANDLES of UMBRELLAS, A. Richter, London.
13,309. FUEL for INTERNAL COMBUSTION MOTORS, G. F. Mort, London.
13,310. CONTROLLING the FLOW of ELECTRIC CURRENTS, G. C. Fricker, London.

15th June, 1903.

13,311. PROTECTION against CONTACT with OVERHEAD ELECTRIC CONDUCTION WIRES, H. Fish, London.
13,312. FANS, A. J. Liversedge, London.
13,313. APPARATUS for PROPELLING VESSELS, R. R. Rook, Manchester.
13,314. MACHINES for PICKING up APPLES, B. T. Howard, Birmingham.
13,315. JOINTS of HINGES, J. J., A. J., and A. Bates, Wolverhampton.
13,316. COAL TRAM COUPLINGS, T. Williams, Maesteg, R.S.O., Glam.
13,317. BICYCLE DRIVING GEAR, W. H. Palmer and H. N. Michaelis, Manchester.
13,318. DESK and SEAT, R. Spencer, Barrow-in-Furness.
13,319. INTERNALLY-STOPPERED BOTTLES, T. S. Payne, Swansea.
13,320. PULLEYS, W. W. and A. E. Booker, London.
13,321. TONING PHOTOGRAPHIC PRINTS, J. P. Holding, Manchester.
13,322. PEGS for PICKETING HORSES, H. T. Ryan, Glasgow.
13,323. NON-INFLAMMABLE CELLULOID, A. Williams and W. C. Parkin, Sheffield.
13,324. BLOUSE for BOYS and GIRLS, J. Carter, Glasgow.
13,325. PREVENTING SKIDDING of PNEUMATIC TIRES, W. L. Jackson, Glasgow.
13,326. CLOSETS, S. H. and M. J. Adams, Scotswood-on-Tyne.
13,327. VALVE SPRING LIFTER. A. W. Berry, Colchester.
13,328. BAND HINGES, G. Whitehouse, Limited, F. H. Tuft, and H. Turner, Wolverhampton.
13,329. PLANING MACHINE TOOL HOLDER, S. E. Watson and F. G. Bentley, Stoke-on-Trent.
13,330. CUTTING BUTTER, A. B. Cleaves, Westbury-on-Trim, near Bristol.
13,331. EXTRACTING from LIQUID MATTER in SOLUTION, T. F. Edgeworth, London.
13,332. FRICTION CLUTCHES, H. S. Hele-Shaw, Liverpool.
13,333. BLIND FITTINGS, J. S. Hill, West Bromwich.
13,334. BUTTON FASTENERS, M. Schubert and O. Rechnitz, Hamburg, Germany.
13,335. CUTTING off WALLPAPER BORDERS, A. L. Bandau, Cologne-on-Rhine, Germany.
13,336. UNWELDED CHAINS, G. Wilke, Barmen, Germany.
13,337. RAZOR, A. T. H. Coward, Sheffield.
13,338. AXLE-BOXES, D. J. Morgan, Cardiff.
13,339. SOCKETS for WROUGHT IRON TUBES, F. J. T. Haskew, London.
13,340. PAPER PINION WHEELS, W. J. H. Reid, Linwood, near Paisley.
13,341. PORTMANTEAUS, P. Krenkel, London.
13,342. GAS BURNERS, E. Liddle and G. E. Druiff, London.
13,343. COKE-CONVEYING APPARATUS, A. A. Johnston, London.
13,344. FURNACES for STEAM BOILERS, G. F. Gallagher, London.
13,345. GAS-BLOWING MACHINE, H. Severin, London.
13,346. ROTARY EXPLOSION ENGINE, H. M. S. Tuckwell, London.
13,347. FISHING HOOK, T. Evans, London.
13,348. BOXES, S. A. Budgett and Reimier and Co., London.
13,349. SWEETMEATS, S. A. Budgett and Reimier and Co., London.
13,350. PHOTOGRAPHIC PLATES, J. T. Burrell, London.
13,351. STAND for HOLDING NEWSPAPERS, E. Crooke, London.
13,352. STEERING AXLES for VEHICLES, G. H. Harrison, Birmingham.
13,353 SEWING MACHINE ACCESSORIES, H. E. Newton.—(*F. Falta, Germany.*)
13,354. PAINTING of EARTHENWARE, V. W. Cox, London.
13,355. BRAKE MECHANISM for WAGONS, J. Corbyn, London.
13,356. CARBURETTERS, J. Grouvelle and H. Arquembourg, London.
13,357. AUTOMATIC REGULATION in CONSTANT-LEVEL CARBURETTERS, J. Grouvelle and H. Arquembourg, London.
13,358. ELECTRIC COUPLINGS, T. Shepherd, London.
13,359. MACHINES for TRIMMING OIL CAKES, A. W. French, London.
13,360. ALBUMS, W. Beese, London.
13,361. PREVENTING ENGINES RACING, F. Giurgevich, London.
13,362. SHEARS, O. Börs, London.
13,363. PRINTING MACHINES, W. H. Lock and T. M. North, London.
13,364. RAISING and LOWERING SCENERY, E. Lytton, London.
13,365. VALVES, B. K Field, London.

13,366. STAMPING PRESSES, J. W. and R. W. Perkins, London.
13,367. COUPLERS, F. W. Le Fall.—(*F. D. Ward, United States.*)
13,368. GOLF BALLS, C. T. Thompson, London.
13,369. TWISTING and SPINNING MACHINES, A. Kleiss, London.
13,370. BEARING RINGS for CYLINDERS, J. E. Loa, Londn.
13,371. EXHAUST PIPE FITTINGS, J. A. Aiton, Londen.
13,372 GENERATORS, W. Bethell, London.
13,373. TOOL CHUCK, M. Margowski and C. Gorick, London.
13 374. PULLEYS, W. A. Trier, London.
13,375 TROUSER STRETCHERS and PRESSERS, F. Stevens, London.
13,376. SANITARY BUCKETS or PAILS, C. R. Ford, London.
13,377. BURNERS for LIQUID FUEL, J. B. Bladon, London.
13 378. CONSTRUCTING GENERATORS, W. A. Johnson, London.
13,379. COMPOUND for AGGLOMERATING PULVERULENT MATTER, R. W. James.—(*C. Giglio and B. Zaouche, France.*)
13 380. PREVENTING HEAT TRANSMISSION, E. Penkala, London.
13,381. TIRE LEVERS, P. B. H. and H. H. P. Seabrook, London.
13,382. BRAKES, T. H. Williamson and W. S. Caddick, Liverpool.
13,383. MOVABLE PARTITIONS or SCREENS, W. Johnson, Liverpool.
13,384. CONDENSER SYSTEM, L. R. Alberger, London.
13,385. MILL PICK, J. H. F. Schumann and C. H. T. Dürr, London.
13,386. PREPARATION of a GROUND-WORK LAYER to PASTEBOARD, &c, H. Bittner and L. L. Dejoux, London.
13,387. CLIPS, G. W. McGill, London.
13,388. KNITTING MACHINES, F. Bruno-Salzer and G. Walther, London.
13,389. PNEUMATIC HARNESS, A. J. Boult.—(*E. Villette, France.*)
13,390. METALLIC PACKING, A. J. Boult.—(*Dujardin and Co., ——.*)
13,391. LABELS, G. E. Howard, London.

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13,392. APPLICATION of HEAT, R. Pritt, Morecambe.
13,393. CRADLE SOLID TIRE WHEEL, G. R. G. Rowe, London.
13,394. TELEPHONES, G. W. Möhrstädt and T. H. Gray, Birmingham.
13,395. SCREW PROPELLERS for SHIPS, J. Willcox, Southampton.
13,396. TIRES, J. A. Maya, London.
13 397. OIL CLOTH FLOOR COVERING, J. Gibson, Manchester.
13,398. TROLLEYS, G. C. Waters, Liverpool.
13,399. ENGINES, M. J. Biddles, W. Pratt, and W. Biddles Leicester.
13,400. DEVICE for HOLDING CANDLES, W. S. McAlister, Glasgow.
13,401. SHIPPING SPANNERS and WRENCHES, J. Park, Glasgow.
13,402. NEEDLE-THREADING APPLIANCE, R. D. Melrose, Glasgow.
13,403. LOOM FORKS, D. Pickles, Burnley.
13,404. BRAKES, H. Smith and B. F. Wright, Coventry.
13,405. AXLE BEARINGS, H. Smith and W. Payne, Coventry.
13,406. ENGINES, W. A. Lloyd's Cycle Fittings, Limited, and F. Howles, Birmingham.
13,407. CARBURETTER, J. E. B. Simpson, Harrogate.
13,408. VICES, A. Krüger, Manchester.
13,409. ROCKING CHAIRS, E. Breare, Addingham, *viâ* Leeds.
13,410. TAKING STEREOSCOPIC PHOTOGRAPHS, T. Brown, Salisbury.
13,411. PYRAMID POWER CHANNEL OPENER, A. Timms and S. Passmore, Northampton.
13,412. MANUFACTURE of CYANIDES, Grossmann's Cyanide Patents Syndicate, Limited, and J. Grossmann, Manchester.
13,413. PRESSURE GAUGES, J. Burden, Birmingham.
13,414. SOLDERING on COVERS of MEAT TINS, C. W. and F. L McKinnon, Glasgow.
13,415. WEAVERS' SHUTTLES, G. Preiss, Glasgow.
13,416. WINDOW SASH REMOVERS, J. H. Finkelstein, Port Talbot, South Wales.
13,417. PIANOFORTE APPARATUS, F. Lott, Waterloo, Lancs.
13,418. COMBINATION BRACELET and BOX, T. Wilcox, Birmingham.
13,419. WASTE REMOVAL in FLAX ROOMS, H. R. Carter, Manchester.
13,420. FIRE-BOXES, L. Greaven, Glasgow.
13,421. SPARROW TRAP, G. E. Parham, Winkfield, Windsor.
13,422. FEED-WATER HEATERS and PURIFIERS, W. A. Gibson, Glasgow.
13,423. HAT RIM PROTECTORS, V. A. Wallace, Ontario, Canada.
13,424. IMPROVED LETTER BINDERS, G. Donaldson, Leeds.
13,425. CYLINDER PRINTING MACHINES for PAPER HANGINGS, T. R. Shillito.—(*J. Fischer, Germany.*)
13,426. SPRING TRACK, R. B. Woolley, London.
13,427. FASTENING DEVICE for DOORS, J. Bellamy, Birmingham.
13,428. SELF-ACTING MULES, A. Bailey, London.
13,429. VEHICLE BRAKES, G. C. Downing.—(*J. F. Brimmer and J. F. Cullman, United States.*)
13 430. MOTOR CYCLES, Humber, Limited, and H. E. Earl, London.
13,431. MANUFACTURING RUBBER GOODS, C. H. Gray, London.
13,432. DISINFECTANT, R. J. Stephens and A. L. Checkland, London.
13,433. FIXING and HANGING WINDOW SASHES, J. Salt, London.
13,434. STEAM TRAPS, J. E. L. Ogden, London.
13,435. METAL DISC WHEELS, A. Reichwald —(*F. Krupp, Germany.*)
13,436. METHOD of SHIFTING POINTS, W. F. Waddell, London.
13,437. DRAUGHT ARM for DISPENSING BEVERAGES, C. Wood and The Ferry Manufacturing Co., Limited, London.
13,438. STAND for MOTOR BICYCLES, W. Ross, London.
13,439. HEN COOP, W. H. Harris, London.
13,440. SPRING BOLTS for DOORS, J. A. Macmeikan, London.
13,441. FEED-WATER HEATERS, T. C. McBride, London.
13,442. BOOTS, H. C. Jenney, London.
13,443. FENDERS for TRAMWAY VEHICLES, G. Hipwood, London.
13,444. FEED-WATER HEATING SYSTEM, T. C. McBride, London.
13,445. HOLDER for MANIFOLD BOOKS, J. E. Brown, London.
13,446. FREE-WHEELS for CYCLES, J. G. Oldfield, Coventry.
13,447. REGULATOR for FANLIGHTS, &c., J. Adams, London.
13,448 RATCHET SPANNER, R. Temple, London.
13,449. SHEET-DELIVERY MECHANISM for PRINTING MACHINES, W. H. Lock.—(*The Michle Printing Press and Manufacturing Company, United States.*)
13,450. ELLIPSOGRAPH, L. Kurka, Loudon.
13,451. FOUNTAIN and STYLOGRAPHIC PENS, J. Blair, New York.
13,452 PACKINGS for STEAM TURBINE SHAFTS, The British Thomson-Houston Company, Limited.—(*A. R Dodge, United States.*)
13,453 DETACHABLE BUCKETS for STEAM TURBINES, The British Thomson-Houston Company, Limited.—(*H. Geisenhoner, United States.*)
13,454. TREATING ORES, T. Huntington and F. Heberlein, London.
13,455. SECURING PLATES to FLOORS, O. Bertazzoli and B. Gazzano, London.
13,456. POWER-TRANSMITTING DEVICE, C. W. Hunt, London.
13,457. SMOKELESS POWDER, P. M. Justice.—(*International Smokeless Powder and Chemical Company, United States.*)
13,458. LAMPS, A D. Ryder and H. E. Dopson, London.
13,459. FASTENINGS for CASEMENTS, The Crittall Manufacturing Company, Limited, and T. H. Bennett, London.
13,460. MAKING ACETYLDIAMIDOSALICYLIC ACID, R. B. Ransford.—(*L. Cassella and Co., Germany.*)
13,461. REVERSING PROPELLERS, E. C. Fowler, London.
13,462. DISTANCE RECORDING APPARATUS, W. Wilson, London.
13,463. GARMENT, S Page, London.
13,464. INTERNAL COMBUSTION ENGINES, A. C. Chew, London.
13,465. MANUAL MOWING MACHINES, I. Latyschew, London.
13,466. FREEING GASES from CARBON DISULPHIDE, A. Töhl, London.
13,467. MICROSCOPES, F. W. W. Baker, London.
13,468. FORMING HEAD for BROOMS, H. F. Heuchel, London.
13,469. PREPARATION of FOOD PRODUCT, F. Bunyan, London.
13,470. BREECH-LOADING ORDNANCE, A. T. Dawson and G. T. Buckham, London.
13,471. KEYS for PERMANENT WAY CHAIRS, W. H. Wolff, London.
13,472. SEWAGE-CONTROLLING APPARATUS, H. Tooley, London.
13 473 PROCESSES for the PRODUCTION of LUBRICANTS, W. P. Thompson.—(*Gesellschaft zur Verwentung der Boleg 'schen wasserlöslichen Mineralöle und Kohlenwasserstoffe G. m. b. H., Germany.*)
13,474. JOINTS for PIPES, C. Halford, London.
13,475. APPARATUS for BORING HOLES, &c., W. H. Dwerryhouse, T. I. Cleasby, and J. Radcliffe, Liverpool.
13,476. GAS GENERATORS, J. E. Dowson, London.
13,477. CYLINDERS for MULTI-COLOUR PRINTING, J. Wojciechowski, London.
13,478. SEED-PLANTING MACHINE, U. A. Fitz-Mautice, London.
13,479. LOCK for FASTENING BRACELETS, F. Spiedel, London.
13 480. POWER-TRANSMITTING MECHANISM, H. J. Haddan.—(*I. Lehman, United States.*)
13,481. STRINGED MUSICAL INSTRUMENTS, W. Waghorn, London.
13,482. MAKING ARTIFICIAL FUEL, W. B. Hartridge, London.
13,483. COFFEE-GRINDING MILL, Kin-Hee, Limited, and E. R. Chasseaud, London.
13 484. PNEUMATIC TIRES for VEHICLES F. Rogers, London.
13,485. CONSTRUCTION of BOOT TREES, G. Care, London.
13 486. ELECTRIC CABLE TERMINALS, W. H. Simmonds, London.
13,487. ELECTRIC SIGNALLING APPARATUS, J. E. Evans-Jackson.—(*American Electric Telephone Company, United States.*)
13,488. IMPROVED SYSTEM of CULTIVATION, R. Hofherr, London.
13,489. RAILWAY CARRIAGE COUPLINGS, J. Willison, London.
13,490. RAILWAY CARRIAGE COUPLINGS, J. Willison, London.
13,491. EXHAUST SILENCERS for GAS ENGINES, J. W. Hornsby and W. J. Holloway, London.
13,492. HAY COLLECTORS, T. M. Jarmain, London.
13,493. RACKS for use in BOOT FACTORIES, W. H. Percival, London.
13,494. PEAT HARVESTING MACHINES, A. Dobson, London.
13,495. TYPE-COMPOSING MACHINES, M. Wehrlin, London.

17th June, 1903.

13,496. DRESS FASTENER, P. Hardy, Liverpool.
13,497. LAMP ASTRAGALS, J. Inglis, Kirkcaldy, N.B.
13,498. SHEET METAL PIPE TRAYS, J. Inglis, Kirkcaldy, N.B.
13,499. RAZOR, J. Biggin, Sheffield.
13,500. AUTOMATIC CUT-OFF GEAR for INTERNAL COMBUSTION MOTORS, W. J. Crossley and J. Atkinson, Manchester.
13,501. INTERNAL COMBUSTION MOTORS, W. J. Crossley and J. Atkinson, Manchester.
13 502. OPERATING CORDS of ELECTRIC TRAM TROLLEY ARMS, A. Taylor, W. Morehead, and T. H. Kingscote, Manchester.
13,503. BRAKES for BICYCLES, G. G. Lusher, Birmingham.
13,504. SUSPENDING HORSES' FOOD BAGS, T. Connor and J. Williams, Cardiff.
13,505. BABY CARRIAGES, A. J. Jacobs, Bristol.
13,506. PREVENTING NICOTINE REACHING the MOUTH from PIPES, T. D. Rollins, Belfast.
13,507. MANUFACTURING ARTIFICIAL STONE, H. Heesom, Manchester.
13,508. TRAMCAR SEATS, R. Clegg and W. Murray, Manchester.
13,509. COLLAPSIBLE BOXES, S. Lynn, and McCaw, Stevenson and Orr, Limited, Glasgow.
13,510. TOBACCO-CUTTING MACHINES, J. Stewart, Glasgow.
13,511. TRAILER, C. W. Formby, Weybridge.
13,512. LOCK CASES, H. Vaughan and A. L. Caron, Wolverhampton.
13,513. SPRING RAKE for HAY-HARVESTING MACHINERY, D. Cavo, Bicester, Oxon.
13,514. NON-REFILLABLE BOTTLES, H. Huth, Southampton.
13,515. CASH REGISTERS, E. W. Bache, Birmingham.
13,516. ADJUSTABLE CHAIR, M. B. McInnes, Motherwell, N.B.
13,517. CYCLES, A. Urok, Glasgow.
13,518. DISPLAYING ADVERTISEMENTS, J. P. C. Barlow, Manchester.
13,519. DISPLAYING ADVERTISEMENTS, J. P. C. Barlow, Manchester.
13,520. SELF-HEATING SHOE, M. C. Gerard, Glasgow.
13,521. BOBBINS, A. Turner. Glasgow.
13,522. SPROCKET WHEELS for VELOCIPEDES, S. Guiterman and Co., Limited.—(*Guiterman Rosenfeld and Co., United States.*)
13,523. MEANS for LOCKING NUTS in POSITION, R. Jones, London.
13,524. CLUTCH MECHANISM for SHAFTING, W. Rawstron and V. Garsden, Rochdale.
13,525. CUTTING off the GAS SUPPLY to a BURNER, S. Haigh, Vancouver, Canada.
13,526. OIL MOTOR ENGINES, F. H. Gerard, London.
13,527. BRAKES for TWO-WHEELED VEHICLES, H. Standish, London.
13,528. WATER MOTORS, B. M. Fletcher, London.
13,529. GUARDS for PUNCHING and SHEARING MACHINES, J. W. Dewhurst and H. M. Lavine, Manchester.
13,530. STOPPING MATERIAL for DENTISTRY, L. Eilertsen, Birmingham.
13,531. EXPLOSIVES, J. Wetter. —(*The Westfälisch-Anhaltische Sprengstoff-Aktiengesellschaft, Germany.*)
13,532. INKING PADS for DUPLICATES, S. Brown, London.
13,533. SPRING CLIPS for TURNING BACK EYELIDS, A. D. Reid and H. W. C. Cox, London.
13,534. LEAKLESS WATER COCKS, F. A. Homer, London.
13,535. INK BOTTLES and INK STANDS, D. McNae, London.
13,536. BUILDING BLOCKS, A. M. Lambert, London.
13,537. ROTARY ENGINES, C. Joly, A. C. J. Charlier, and J. C. Paterson, London.
13,538. NECKTIES, P. F. Allen, London.
13,539. THE GAME of DIAMONDS, R. A. Cotes, London.
13,540. INCANDESCENT MANTLES, J. E. T. Woods and J. B. Hamond, London.
13,541. INCANDESCENT MANTLE SUPPORTS, W. T. Sugg, London.
13,542. REGENERATIVE KITCHEN STOVES, P. Philippon, London.
13,543. TREATING RAW HIDES and SKINS, H. Klein, London.
13,544. BOILERS, G. L. A. Gamondes, London.
13,545. ORNAMENTED HOLLOW GLASS WARE, A. Schünzel, London.
13,546. BRAKES, E. Freund, London.

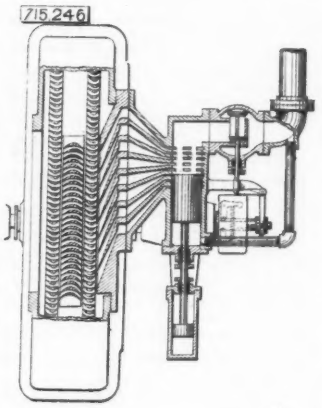
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

715,246. GOVERNOR for ELASTIC-FLUID TURBINES, *C. G. Curtis, New York, N.Y.—Filed April 18th*, 1899.

Claim.—The combination with an elastic-fluid turbine, of a sectional nozzle for permitting the passage of varying volumes of elastic fluid to the same, a cylinder into which all the sections of said nozzle

715,246

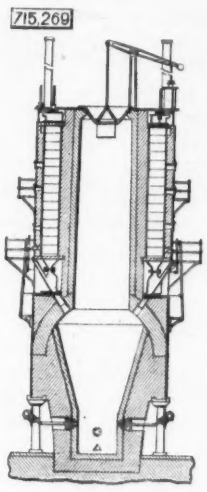


extend, a piston in the cylinder arranged to disclose one or more of the sections of the sectional nozzle, a balanced regulating valve for permitting the introduction of varying volumes of elastic fluid into the cylinder, a main pipe for supplying elastic fluid to the regulating valve, and a pipe connecting the main pipe with the cylinder opposite to the admission port for the working fluid, substantially as set forth.

715,269. FURNACE for SMELTING IRON, *H. A. Jones, New York, N.Y.—Filed April 24th*, 1899.

Claim.—The combination with the blast furnace having a crucible for molten metal, a flaring fusion chamber above the crucible, a cylindrical chamber above the fusion chamber and of smaller diameter than the upper part of the said fusion chamber, and a series of equally-spaced vertical recesses in the furnace wall, of a series of deoxidising ore retorts in said recesses, means for covering the same, receiving hoppers containing the deoxidised ore beneath said retorts, supply hoppers connected to the receiving hoppers, valves between said receiving and supply hoppers, tubes extending upward from the supply hoppers through which devices may be inserted to ensure the proper discharge of the deoxidised ore from the supply hoppers, passages from the supply hoppers to the upper part of the fusion chamber, valves in said passages, platforms around the furnace and

715,269

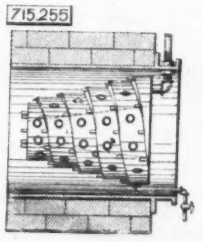


means for operating the aforesaid valves therefrom, and means for visually observing the interior of the deoxidising retorts, substantially as set forth.

715,255. STEAM BLOWER, *E. Gibson, Jersey City, N.J. Filed March 7th*, 1902.

Claim.—A steam blower having two tapering shells or tubes, one within the other, cast integral with a liberal space between, offsets M^4 on the exterior shell M^5, the orifices *m* and nozzles N in such offsets, a con

715,255

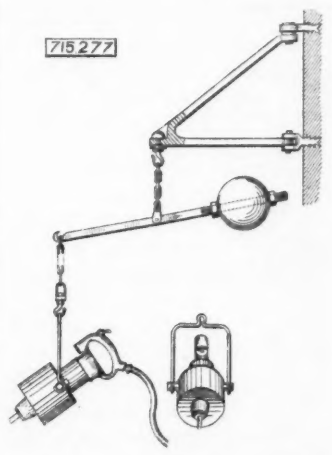


nection for supplying steam to the space between the shells, and provisions for separating water in such blower and discharging it through the drain pipe D with controlling means D^1, arranged in an aperture *a* in the wall A so as to serve with a steam boiler B, substantially as herein specified.

715,277. PORTABLE AUTOMATIC HAMMERING TOOL, *F. M. Leavitt, Brooklyn, N.Y.—Filed July 2nd*, 1901.

Claim.—(1) In an automatic hammering tool, the combination with the casing, of a weight fixed directly and rigidly to said casing. (2) The combination with an automatic hammering tool having a casing, of a weight fixed directly and rigidly to said casing, and a means for suspending said tool. (3) The combination with an automatic hammering tool having a casing, of

715,277



a weight fixed directly and rigidly to said casing, a means for suspending said tool, and a counterweight for said tool. (4) The combination with an automatic hammering tool having a casing, of a weight fixed directly and rigidly to said casing, a counterweight for said tool, and a crane carrying said tool. (5) The combination with an automatic hammering tool having a casing, of a weight fixed directly and rigidly to said casing, a counterweight for said tool, and a crane carrying said tool and said counterweight.

END OF VOL. XCV.

The Engineer.

Registered as a Newspaper

OFFICE FOR ADVERTISEMENTS AND PUBLICATION, 33, NORFOLK STREET, STRAND, W.C.

VOL. XCV.—No. 2478] LONDON: FRIDAY EVENING, JUNE 26, 1903. [PRICE SIXPENCE.

[No. 80]
Office of the Receiver-General and Director of Contracts, Valletta, 6th June, 1903.

Sealed Tenders will be received at this office up to 11 a.m. on Friday, the 10th July next, for the SUPPLY of FLANGED CAST IRON PIPES and IRREGULAR CASTINGS.

Tenders received after the said date and hour will not be considered.

Tenders are to be accompanied with a deposit of £100, to be made in the office of the Crown Agents by tenderers residing in Great Britain not having a representative in Malta and in this office by local tenderers.

The tenderer whose offer is accepted shall be held to have bound himself to an agreement, and may be compelled to carry out the obligations arising from his Tender, notwithstanding that he may not have signed a formal contract.

The Government reserves to itself the right of accepting or rejecting any of the Tenders received.

Particulars, specifications, &c., may be obtained on application to the Superintendent of Public Works in Malta or to the Crown Agents for the Colonies, Downing-street, London.

WM. CASOLANI,
Receiver-General and Director of Contracts.

3211

India Office.
Whitehall, 24th June, 1903.

The Secretary of State for India in Council is prepared to receive TENDERS from such persons as may be willing to SUPPLY:—

1. CAST IRON CHAIRS.
2. SPANS, 20ft. and 40ft.
3. BRASS BOILER TUBES.
4. CARRIAGE AND WAGON IRONWORK.

The conditions of contract may be obtained on application to the Director-General of Stores, India-office, Whitehall, S.W., and Tenders are to be delivered at that office by Two o'clock p.m. on Thursday, the 2nd July, 1903, for No. 1, and on Tuesday, the 7th July, 1903, for Nos. 2, 3, and 4, after which times respectively no Tender will be received.

E. GRANT BURLS,
Director-General of Stores.

3220

The Manchester Steam Users' ASSOCIATION.

The Annual General Meeting of the members was held in the Board-room of the Association, at their Offices, 9, Mount-street, Manchester, on Tuesday, 23rd June, ADAM DUGDALE, Esq. (Blackburn), President, in the Chair, when the following resolutions were adopted:—

Moved by the CHAIRMAN, seconded by CHARLES HEATON, Esq. Bolton, and resolved:—

"That the Report of the Committee of Management to the subscribers be adopted."

Moved by Councillor WADSWORTH (Halifax), seconded by W. T. EVANS, Esq. (Messrs. Thos. Roebuck and Co., Manchester), and resolved:—

"That the thanks of the Association are due, and are hereby presented to the Committee of Management for their past services, and that the following gentlemen be elected the Committee for the ensuing year, with power to add to their number."

Committee of Management.
ADAM DUGDALE, Esq., Blackburn.
CHARLES HEATON, Esq., Bolton.
RALPH PEACOCK, Esq., Gorton.
HENRY HARRISON, Esq., Blackburn.
THOMAS FARKINSON, Esq., Manchester.
H. H. SMITH-CARINGTON, Esq., Openshaw.
HAROLD LEE, Esq., Manchester.

Mr. Dugdale having vacated the chair, it was taken by CHARLES HEATON, Esq., when it was moved by HAROLD LEE, Esq. (Manchester), seconded by EDWARD PEEL, Esq. (Bury), and resolved:—

"That the thanks of the Association are due, and are cordially given to Adam Dugdale, Esq., for presiding at this meeting, and for the constant service he has rendered."

ROBERT TONGE,
Secretary.

9, Mount-street, Albert-square,
Manchester, 23rd June, 1903. 3165

Warning.—To Makers and Users OF POWER PRESSES OR LIKE MACHINES FOR DRAWING OR STAMPING METALLIC SEAMLESS HOLLOW-WARE.—TAYLOR and CHALLEN, Limited, of Birmingham, Engineers, WILL INSTITUTE IMMEDIATE LEGAL PROCEEDINGS AGAINST INFRINGERS (whether as makers or users) of any of their several patents relating to above.

SAUNDERS, BRADBURY & SAUNDERS,
37, Temple-row, Birmingham,
Y724a Solicitors for Taylor and Challen, Limited.

County Borough of Halifax. TECHNICAL INSTRUCTION COMMITTEE.

Applications are invited for the post of FIRST ASSISTANT in the Mechanical and Electrical Engineering Department at the commencing salary of £150 per annum.

Candidates must state that they have read the printed particulars, which can be obtained on application to the Principal, Municipal Technical School, Halifax.

Applications must be sent to the Principal not later than June 30th, 1903. 2067

Hackney Institute. — The Governors are prepared to receive APPLICATIONS for the following APPOINTMENTS:—

LECTURER in PHYSICS and ELECTRICAL ENGINEERING (Head of the Department). Salary to commence at £250 per annum.

ASSISTANT LECTURER in MECHANICAL ENGINEERING. Salary £150 per annum.

The Lecturers will be required to give their whole time to the work of the Institute.

Applications, which must be forwarded on or before July 1st, 1903 must be made on forms to be obtained from the Hon. Clerk to the Governors, Hackney Institute, Dalston-lane, N.E. 3081

Head Master Required for the Marine School of South Shields. Must be M.A. of Cambridge or Oxford. Qualifications, Mathematics and Engineering. Salary £300.—Further information may be obtained from R. CHAPMAN, 67, King-street, South Shields, to whom applications (with copies of testimonials) must be sent before 31st July. 3075

London County Council.—The Technical Education Board of the London County Council is prepared to receive APPLICATIONS for the following APPOINTMENTS at the L.C.C. Paddington Technical Institute, Saltram-crescent, W.

(a) HEAD of the PHYSICAL DEPARTMENT.
(b) HEAD of the CHEMICAL DEPARTMENT.
(c) CHIEF ASSISTANT in the ENGINEERING DEPARTMENT.

The commencing salary for each appointment has been fixed at £250 per annum.

The persons appointed will be required to give their whole time to the work of the Institute.

Applications, which must be forwarded on or before Monday, 6th July, 1903, must be made on forms to be obtained of the Secretary of the Board, 116, St. Martin's-lane, W.C.

G. L. GOMME,
Clerk of the Council.

County Hall, S.W.,
22nd June, 1903. 3219

University College, Bristol.— The Council invite APPLICATIONS for the POST of JUNIOR LECTURER and DEMONSTRATOR in ENGINEERING.

Salary £120 per annum.

Applications to be sent in by July 6th to the undersigned, from whom further particulars may be obtained.

JAMES RAFFER,
Registrar and Secretary.

3048

Bath Corporation Waterworks. CONTRACT No. 1. TO CONTRACTORS.

The Waterworks Committee of the Corporation of Bath are prepared to receive TENDERS for the following WORKS:—

(1) The CONSTRUCTION of an OPEN RESERVOIR, about 100ft. diameter, to hold 500,000 gallons, situated about five miles from Bath.
(2) DRIVING ADITS, CUT and COVER and LAYING and JOINTING PIPES and BUILDING MANHOLES for the purpose of collecting several springs in the St. Catherine's Valley above Batheaston.
(3) EXCAVATING and REFILLING TRENCHES, and CARTING, LAYING, and JOINTING about 6 MILES of CAST IRON PIPES, 18in. and 12in. diameter, and about 4 MILES of CAST IRON PIPES, 9in. 6in., and 4in. diameter; LAYING a LINE of 18in. PIPES ACROSS and UNDER the RIVER AVON at Bath, together with all contingent work in connection therewith.
(4) OTHER SUBSIDIARY WORKS.

The drawings may be seen on and after the 25th instant, and copies of the specification, form of Tender, and schedule of quantities may be obtained on application to Messrs. William Fox and R. A. Tatton, MM. Inst. C.E., 5, Victoria-street, Westminster, S.W., on payment of a deposit of £10, which will be returned, after the contract has been entered into, to every person making a bonâ fide Tender, with the schedule of quantities fully priced out, and on returning the documents entrusted to them.

In the event of a Tender being withdrawn the deposit will be forfeited.

Sealed offers, endorsed "Tender for Reservoir and Pipe Laying," addressed to the undersigned, will be received up to noon on July 10th next.

A copy of the contract to be entered into, and the other documents referred to in the specification, may be seen at my office.

The Council do not bind themselves to accept the lowest or any Tender, and reserve the right to divide the contract.

The Engineer, or his representative, will be at Bath on June 29th and July 6th to point out the site of the intended works.

B. H. WATTS,
Town Clerk.

Guildhall, Bath,
16th June, 1903. 3118

Bath Corporation Waterworks. CONTRACT No. 2 TO PIPE FOUNDERS.

The Waterworks Committee of the Corporation of Bath are prepared to receive TENDERS from pipe founders for the MANUFACTURE and DELIVERY of about 2100 TONS of CAST IRON PIPES, 18in. to 4in. diameter, together with about 45 TONS of special CASTINGS.

The pipes to be delivered at one of the railway goods yards, or at the Canal Wharf in Bath.

The specification, form of Tender, and schedule of quantities, may be obtained on application to Messrs. William Fox and R. A. Tatton, M.M. Inst. C.E., 5, Victoria-street, Westminster, S.W., upon payment of a deposit of £5, which will be returned, after the contract has been entered into, to every person making a bonâ fide Tender, with the schedule of prices fully priced out.

In the event of a Tender being withdrawn the deposit will be forfeited.

Sealed offers, endorsed "Tender for Pipes," addressed to the undersigned, will be received up to noon on July 10th next.

The Council do not bind themselves to accept the lowest or any Tender.

B. H. WATTS,
Town Clerk.

Guildhall, Bath,
16th June, 1903. 3119

Bath Corporation Waterworks. CONTRACT No. 3. TO VALVE MAKERS.

The Waterworks Committee of the Corporation of Bath are prepared to receive TENDERS from Valve Makers for the MANUFACTURE and DELIVERY of sundry SLUICE VALVES, AIR VALVES, HYDRANTS, SURFACE BOXES, and other accessories required in connection with the laying of about 10 miles of Pipes, varying from 18in. to 4in. diameter.

The valves to be delivered at one of the railway goods yards, or at the Canal Wharf in Bath.

The specification, form of Tender, and schedule of quantities may be obtained on application to Messrs. William Fox and R. A. Tatton, M.M. Inst. C.E., 5, Victoria-street, Westminster, S.W., on payment of a deposit of £2, which will be returned, after the contract has been entered into, to every person making a bonâ fide Tender with the schedule of quantities fully priced out.

In the event of a Tender being withdrawn the deposit will be forfeited.

Sealed offers, endorsed "Tenders for Valves," addressed to the undersigned, will be received up to noon on July 10th next.

The Council do not bind themselves to accept the owest or any Tender.

B. H. WATTS,
Town Clerk.

Guildhall, Bath,
16th June, 1903. 3120

Bengal-Nagpur Railway Com- PANY, LTD.

The Directors are prepared to receive TENDERS for 1 STEEL PONTOON LANDING STAGE.

Specifications and forms of Tender can be obtained at the Company's Office, No. 132, Gresham House, E.C.

For each specification a fee is charged, which will not be returned.

Tenders to be delivered not later than noon on Friday, 17th July, 1903.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
ROBERT MILLER,
Managing Director.

3234

Borough of Dewsbury.—Electric LIGHT AND POWER SUPPLY.

The Electricity Committee of the Borough of Dewsbury invite TENDERS for the SUPPLY, DELIVERY, and ERECTION of ONE LANCASHIRE BOILER.

Copies of the specification, with form of Tender and general conditions, can be obtained from Mr. R. H. Campion, Borough Electrical Engineer, Bradford-road, Dewsbury, on deposit of £1, which sum will be returned on receipt of a bonâ fide Tender.

Tenders on the prescribed form, in sealed envelopes, and addressed to the Chairman, Electricity Committee, Town Hall, Dewsbury, must be delivered on or before mid-day, July 1st.

The Council do not bind themselves to accept the lowest or any Tender.

H. ELLIS,
Town Clerk.

Town Hall, Dewsbury. 3094

City of Coventry.—Electricity WORKS EXTENSIONS.
PIPE WORK.
ECONOMISER.
COAL CONVEYING PLANT.
STOKERS.
SUNDRIES.

The Corporation of Coventry are prepared to receive TENDERS for the SUPPLY and ERECTION of the above.

Copies of the specification may be obtained from the undersigned on receipt of £5 5s., which sum will be returned on receipt of a bonâ fide Tender.

Tenders will only be considered for a section or sections, and not for part of a section.

The Corporation do not bind themselves to accept the lowest or any Tender.

Tenders to be addressed to the Town Clerk, Hay-lane, Coventry, and must be received by him on or before 10 a.m., July 2nd.

JOSEPH A. JECKELL,
Engineer.

Corporation Electricity Works,
Sandy-lane, Coventry. 3079

Borough of Preston. — Ribble NAVIGATION AND PRESTON DOCK.

The Corporation of Preston are prepared to arrange terms with persons willing to CONSTRUCT, EQUIP, and WORK a GRAVING DOCK, near their Albert Edward Dock.

Plan of the site and particulars may be obtained on application to James Barron, Engineer and General Superintendent, Dock Offices, Preston.

HENRY HAMER,
Town Clerk.

Town Hall, Preston,
18th June, 1903. 3147

Borough of Weymouth and MELCOMBE REGIS.
ELECTRIC LIGHTING.

The Corporation of Weymouth and Melcombe Regis invite TENDERS for the SUPPLY, DELIVERY, and ERECTION of the following, in connection with the electric lighting of the town:—

CONTRACT No. 1.—Lancashire Boilers.
" No. 2.—Engines and Dynamos.
" No. 3.—Overhead Travelling Crane.
" No. 4.—Switchboard and Battery Boosters.
" No. 5.—Storage Battery.
" No. 6.—Arc Lamps and Arc Lamp Posts.
" No. 7.—Pipework, Feed Pumps, Economiser, Ejector Condensers, &c.
" No. 8.—Distributing Mains and Feeders.

Copies of specifications Nos. 1 to 7 inclusive, with forms of Tender and general conditions, can be obtained on and after Saturday, the 27th June, and copies of specification No. 8, with the same conditions and form of Tender, on and after Wednesday, July 1st, from the undersigned on payment of £2 2s. for each specification, which amount will be returned on receipt of a bonâ fide Tender.

The specifications and drawings can be seen at (but not obtained from) the offices of the Consulting Engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, London, S.W.

Tenders, on the prescribed form, in sealed envelopes, and endorsed on the outside "Electric Lighting, Tender for No. — Contract," must be delivered at my office on or before the 19th July, 1903.

The Corporation do not bind themselves to accept the lowest or any Tender, and no allowance will be made for any expense incurred in the preparation of any Tender.

RICHARD NICHOLAS HOWARD,
Town Clerk.

Town Clerk's Office,
Municipal Offices, Weymouth,
24th June, 1903. 3208

New Asylum for the County of MIDDLESEX, AT NAPSBURY, NEAR ST. ALBANS, HERTS.
TO ENGINEERS AND OTHERS.

The Visiting Committee of the above Asylum invite TENDERS for (a) SUPPLYING and FIXING certain HOT WATER WARMING APPARATUS to detached buildings. Hot and Cold Water Services. Tanks, Hydrant Mains and Fittings, Steam and other Cooking Apparatus, and Hand Laundry Plant, at the above Asylum.

(b) SUPPLYING and FIXING certain STEAM PIPES. CALORIFIERS, RADIATORS, &c., to the main Asylum buildings and Hospital.

Bills of quantities are being prepared by Messrs. Young and Brown, of 104, High Holborn, W.C., London, as regards each section of the work.

Engineers and others who are willing to Tender for either section or both sections of the work must send in their names, together with a statement of work which they have executed and a deposit of £10 10s., on or before the 25th day of June, 1903. Firms Tendering for both sections of the work are only required to send in one deposit of £10 10s.

The bills of quantities will be forwarded in due course.

The Tenders must be delivered, as noted in the form, not later than noon on the 6th day of July, 1903. Separate Tenders are required for each section.

The amount of the deposit will be returned to persons who have sent in bonâ fide Tenders.

The Committee do not bind themselves to accept the lowest or any Tender.

Apply, enclosing above deposit, to the Clerk to the Napsbury Asylum Committee, W. G. Austin, Esq., the Guildhall, Westminster. 3084

Royston Urban District Council. NEW WATERWORKS.
TO PIPE FOUNDERS, ENGINEERS, CONTRACTORS, AND OTHERS.

The above-named Council invite TENDERS for the following WORKS, namely:—

CONTRACT No. 1.

The supply of about 1 mile of 6in. Metal Socketted Pipes and Special Castings.

CONTRACT No. 2.

The supply of about 1¼ miles of 5in. Metal Socketted Pipes and Special Castings.

CONTRACT No. 3.

The supply of Valves, Hydrants, Air Valves, Metal Casings, &c., for the 6in. and 5in. Mains.

CONTRACTS Nos. 4 and 5.

The laying of about 1 mile 6in. and about 1¼ miles 5in. Metal Water Pipes and the fixing of Valves, Hydrants, and Air Valves.

CONTRACT No. 6.

The construction of a Covered Service Reservoir of Brick, Stone, and Concrete, and a Fence Wall round the intended reservoir.

The above intended works are situate in the townships of Monk Bretton and Carlton, near Barnsley.

Drawings and specifications can be seen, and bills of quantities obtained on application to the Engineer, Mr. J. Henry-Taylor, M. Inst C.E., at his office in Barnsley, on payment of Two Guineas, which will be returned on receipt of a bonâ fide Tender.

Tenders, properly sealed and endorsed, are to be delivered to the undersigned not later than 10 a.m. on Thursday, the 2nd day of July, 1903.

The Council do not bind themselves to accept the lowest or any Tender, and persons tendering do so at their own expense.

JOSEPH RALEY,
Clerk to the said Council.

Regent-street,
Barnsley,
17th June, 1903. 3157

Swansea Harbour Trust. CONTRACT FOR HYDRAULIC CRANE.

The Swansea Harbour Trustees invite TENDERS for a 30-cwt. PORTABLE HIGH PEDESTAL HYDRAULIC CRANE with a radius of 40ft.

Further particulars can be obtained on application to the Trustees' Engineer, Mr. A. O. Schenk, M. Inst. C.E., at the Harbour Offices, Swansea.

Tenders, sealed and marked "Hydraulic Crane," should be delivered to the undersigned before 10 a.m. Thursday, 9th July, 1903.

The Trustees do not bind themselves to accept the lowest or any Tender.

TALFOURD STRICK,
Clerk.

Harbour Offices,
19th June, 1903. 3152

TO ENGINEERS AND OTHERS.

The Metropolitan Asylums Board invite TENDERS for FITTING UP HOT WATER SUPPLY APPARATUS, &c., at
1. LEAVESDEN ASYLUM,
2. CATERHAM ASYLUM.

in accordance with drawings and specification prepared by Mr. W. T. Hatch, A.M.I.C.E., M.I.M.E., Engineer and Surveyor to the Board.

Drawings, specification, conditions of contract, and form of Tender may be inspected at the office of the Board, Embankment, E.C., on and after Saturday, 27th June, 1903, and can be obtained upon payment of a deposit of £3 in each case.

The amount of the deposit will be returned to persons who have sent in bonâ fide Tenders in accordance with the requirements.

Tenders, addressed as noted on the forms, must be delivered at the office of the Board not later than 10 a.m. on Tuesday, 14th July, 1903.

By order,
T. DUNCOMBE MANN,
Clerk to the Board.

22nd June, 1903. 3225

TO CONTRACTORS AND OTHERS.

The London County Council is prepared to receive TENDERS for WORKS to be executed in connection with the CONSTRUCTION of a PIER and RIVER WALL, and the LAYING DOWN of CONDENSING WATER-PIPES at the Electricity Generating Station to be established by the Council at Greenwich.

Persons desiring to submit Tenders may, on and after Wednesday, 1st July, obtain the drawings, specifications, bills of quantities, form of Tender, and other particulars at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of the sum of £10. This amount will, after the Council or its Committee shall have come to a decision upon the Tenders received, but not before, be returned to the tenderer, provided he shall have sent in a bonâ fide Tender and not have withdrawn the same.

Tenders must be upon the official forms, and the printed instructions contained therein must be strictly complied with.

The contractors will be bound by the contract to pay to all workmen (except a reasonable number of legally bound apprentices) employed by them wages at rates not less, and to observe hours of labour not greater, than the rates and hours set out in the Council's list, and such rates of wages and hours of labour will be inserted in and form part of the contract by way of schedule.

Each Tender is to be delivered at the County Hall, in a sealed cover addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Pier, River Wall, &c., Greenwich Generating Station."

No Tender will be received after Ten o'clock a.m. on Tuesday, 14th July, 1903.

Any Tender which does not comply with the printed instructions for Tender may be rejected.

The Council does not bind itself to accept the lowest or any Tender, and it will not accept the Tender of any person or firm who shall on any previous occasion have withdrawn a Tender after the same had been opened, unless the reasons for the withdrawal were satisfactory to the Council.

G. L. GOMME,
Clerk of the Council.

County Hall,
Spring-gardens, S.W.,
26th June, 1903. 3218

Tyne Improvement Commission. CONSTRUCTION, DELIVERY, and FIXING of FLOATING LANDING STAGES for Market Place Ferry, North and South Shields.

CONSTRUCTION and DELIVERY of STEAM PADDLE FERRYBOAT for Passenger Traffic between North Shields and South Shields.

Notice is hereby given that the DATE on which TENDERS for the above must be delivered to the undersigned at the Commissioners' Offices, Bewick-street, Newcastle-upon-Tyne, is EXTENDED to SATURDAY, the 22nd August, 1903.

ROBERT URWIN,
Secretary.

Tyne Improvement Commission,
Bewick-street, Newcastle-upon-Tyne,
22nd June, 1903. 3160

East Sussex County Asylum, HAYWARD'S HEATH. — FITTER REQUIRED. Wages 24s. per week.—Apply to the MEDICAL SUPERINTENDENT, as above, stating age, and giving references. 3163

The Colne Valley and Halstead Railway Company REQUIRE the SERVICES of an ENGINEER and MANAGER.—Applications to be made in writing, stating salary required, to W. G. BAILEY, Secretary, Halstead Station, Essex, on or before 12th July, 1903. 3231

The Municipal Corporation of PORT ELIZABETH.
APPOINTMENT OF ELECTRIC LIGHTING ENGINEER.

The undersigned are by cable authorised to receive from gentlemen not over 40 years of age APPLICATIONS in detail for the above APPOINTMENT.

The candidates must be qualified and capable to (a) design a scheme for the lighting of the town and the supply of electricity for private purposes; (b) supervise the installation of the whole plant; (c) act as Resident Municipal Electrical Engineer, discharging such duties as are usual in similar appointments under a British Corporation.

The officer appointed will be required to devote the whole of his time to the duties of the office, and to enter into an agreement to remain in the service of the Corporation for a period of not less than three years.

The salary to be paid is for the first year £600, and rising by annual increments of £50 to £750.

The Corporation will supply the officer appointed with a first-class passage from London to Port Elizabeth.

Canvassing, personally or otherwise, whether in London, the Provinces, or Port Elizabeth, will disqualify any candidate.

There is no special form of application, but each candidate is required, in addition to his professional status, and his age last birthday, to set out in detail where he was educated, to whom he was articled, the appointments he has held (and these in chronological order), and to enclose copies (not originals) of not more than six testimonials of recent date.

The above applications must be deposited at the offices of the undersigned not later than noon on Thursday, 9th July next.

DAVIS and SOPER,
Agents of the Municipal Corporation of Port Elizabeth.

54, St. Mary Axe, London, E.C.,
24th June, 1903. 3207

Wanted, a Competent and energetic MANAGER for Foundry, Agricultural Implement and Engineering Business, with retail ironmonger's business attached, in a country town; about fifty men employed; must be prepared to superintend and manage the works, and also attend markets; accountant clerk kept.—Address, stating age, previous experience, and salary required, with copies of testimonials, to 3141, Engineer Office, 33, Norfolk-street, Strand, W.C. 3141

Wanted, Assistant Works MANAGER, with practical experience in Galvanising.—Apply, by letter, to JOHN LYSAGHT, Limited, Bristol. 3154

Wanted, at a Colliery, a First- CLASS MECHANICAL ENGINEER to act as Enginewright. Must have had colliery experience, be able to prepare plans for further developments, be a good organiser of men, six o'clock man, about 35 years of age, and well recommended. Salary £4 per week, with house and coal.—Address, P618, Engineer Office, 33, Norfolk-street, Strand, W.C. P618

Wanted, Contractor's Engineer, able to use Theodolite and Level; accustomed to general public works. — Address, stating age, experience, references, and salary required, to 3176, Engineer Office, 33, Norfolk-street, Strand, W.C. 3176

Wanted, for Works in India, an ASSISTANT MECHANICAL ENGINEER, of good general education and all-round training; a young man with a practical knowledge of constructional ironwork preferred.—Address, stating age and experience, 3072, Engineer Office, 33, Norfolk-street, Strand, W.C. 3072

Manager Wanted for Compressed Gas Works, making oxygen, carbonic acid, nitrous oxide, Glauber's salt, and valves for gas bottles. Must be a thoroughly trained chemist, preferably with a science degree, and be accustomed to the management of men and the erection of machinery and plant. State age, experience, and salary expected, and send references and copies of testimonials.—R. V. JACKSON, care of Scotch and Irish Oxygen Co., Ltd., Polmadie, Glasgow. 2074

For continuation of Small Advertisements see pages II., III., IV., *and* LXVIII.

*** *Index to Advertisements page* LXVII.

Assistant Required with Knowledge of details of Overhead Trolley System.—Apply, in own handwriting, stating age, experience, and remuneration required, to FRITCHARD, GREEN and CO., 37, Waterloo-street, Birmingham. P590

Engineer.—Wanted, for Service in India, an energetic and capable young unmarried MAN of good education. One with a knowledge of electricity and of oil engines preferred.—Apply by letter to ENGINEER, care of Abbott's, 32, Eastcheap, London, E.C. P579

Manager.—Wanted, for Large modern Marine Engine Works, an experienced, well educated, and energetic MANAGER. Applications will be treated in strictest confidence. Give age, references, and salary.—Address, Box 879, Willing's Advertisement Offices, 125, Strand, London, W.C. 3192

Patent Agent (Chartered) in Provinces REQUIRES ASSISTANT. Must be competent specification clerk and draughtsman, with considerable previous experience.—Address, stating age, experience, salary required, and when at liberty, to 3170, Engineer Office, 33, Norfolk-street, Strand, W.C. 3170

Young Engineer, Shop Trained, to ASSIST PRINCIPAL of Manchester engineering works in the preparation of estimates, and with correspondence.—Address, 3206, Engineer Office, 33, Norfolk-street, Strand, W.C. 3206

Wanted, a First-class Mechanical DRAUGHTSMAN.—Apply, with full particulars of experience, age, and salary required, to W. H. ALLEN, SON and CO., Limited, Bedford. 3093

Wanted, a Good Draughtsman, accustomed to Hydraulic and General Machinery.—Address, 3159, Engineer Office, 33, Norfolk-street, Strand W.C. 3159

Wanted at Once, Good Draughtsman. Must be well experienced in Hydraulic Crane and Constructional Work. Good salary for suitable man.—Apply, stating full particulars, age, salary required, &c., to C. and A. MUSKER, Ltd., Liverpool. 3223

Wanted, Constructional DRAUGHTSMAN, thoroughly accustomed to preparation of working drawings of heavy girderwork and large corrugated iron buildings. Good permanency for smart man.—Address, stating age, qualifications, and salary required, to 3076, Engineer Office, 33, Norfolk-street, Strand, W.C. 3076

Wanted, for the North of England, good DRAUGHTSMAN (not Chief), thoroughly conversant with the best English and American Machine Tool practice.—Address, stating age (which must not exceed 40), salary required, and experience, 3216, Engineer Office, 33, Norfolk-street, Strand, W.C. 3216

Wanted. — Good Mechanical DRAUGHTSMAN REQUIRED at once in London Office of Contractors. Must be quick and reliable, and capable of producing neat finished drawings of power station arrangements.—Address, 3185, Engineer Office, 33, Norfolk-street, Strand, W.C. 3185

Wanted Immediately, by an American firm, DRAUGHTSMAN familiar with the general arrangement and construction of large power-houses. Only experienced men need apply.—Address, P602, Engineer Office, 33, Norfolk-street, Strand, W.C. P602

Wanted Immediately, Experienced DRAUGHTSMAN, for detail automobile work; also good TRACER for above.—HEMINGWAY, care of Barber, 5, Palmer-street, Westminster. P603

Wanted, in an Engineer's Office in Westminster, a competent DRAUGHTSMAN, having experience in general Constructional Work, but especially in the design of Portable Steel and Wood Buildings. —State age, references, and salary required, to Box 806, care of Brown's, 17, Tothill-street, Westminster. 3222

Wanted, Mechanical Draughtsman, experienced in the Design of Factory Buildings and Arrangement of Machinery; one accustomed to power gas plants and electrical driving preferred.—State age, experience, and salary required, to 3177, Engineer Office, 33, Norfolk-street, Strand, W.C. 3177

A Draughtsman with Experience in Constructional Steel Work is REQUIRED by a Consulting Electrical Engineer in the North of England. Applicants must give particulars of their technical training and state salary required.—Address, 3167, Engineer Office, 33, Norfolk-street, Strand, W.C. 3167

Car Draughtsmen Wanted by progressive Firm, for Railway Carriage and Tramcar work; good wages to suitable men.—Address, stating age, experience, and wages required, to Box 405, at Horncastle's, 61, Chespside, London. 3086

Chief Draughtsman Wanted by old-established Firm of High-class Machine Tool Makers, must have thorough knowledge of and be conversant with latest designs of medium and light tools.—Address, 2090, Engineer Office, 33, Norfolk-street, Strand, W.C. 2090

Chief Draughtsman Wanted, to TAKE SOLE CHARGE of drawing-office in large engineering works in the Midlands; one with knowledge of the motor industry preferred; must be first-class man.—State experience, salary required, to 3187, Engineer Office, 33, Norfolk-street, Strand, W.C. 3187

Draughtsman (First-class) WANTED, with experience in Air-compressing Work preferred. — Address, stating age, experience, and salary required, P607, Engineer Office, 33, Norfolk-street, Strand, W.C. P607

Draughtsmen Required by Large Electrical Manufacturing Firm in Midlands; used to switchboards, dynamos, or steam engines.—State age, experience, salary, and how soon able to commence duties. to 3178, Engineer Office, 33, Norfolk-street, Strand, W.C. 3178

Draughtsman Wanted, Must have thorough knowledge of Gearing, more especially Worm and Spiral, Tooth Curves, Strengths, &c. One who has a knowledge of Machine Tool building preferred. State age, experience, where last employed, and salary required. Permanency for really smart man; none others need apply.—Address, 3175, Engineer Office, 33, Norfolk-street, Strand, W.C. 3175

Draughtsman Wanted Immediately, with Tramway or Railway Car experience, £2 per week.—Write fully, or call at once, THE ROOTS MOTOR and MOTOR CAR, Ltd., 4, Chichesley-street, York-road, Westminster Bridge-road. 3188

Draughtsman Wanted, One Experienced in Switchboard Work preferred.—Address, stating age, experience, and salary required, to 3146, Engineer Office, 33, Norfolk-street, Strand, W.C. 3146

Draughtsman Wanted. One used to Pumping Machinery and preparation of Drawings showing the lay-out of same.—Address, stating age, experience, and salary required, to 3191, Engineer Office, 33, Norfolk-street, Strand, W.C. 3194

Draughtsman Wanted, Well up in Steel Roof Work, able to draw, calculate stresses, and take out quantities accurately and quickly; will also have charge of two juniors. Write fully as to experience, stating also age and salary asked. To an energetic hard worker on the position will be an improving one.—REES and KIRBY, Limited, Constructional Engineers, Swansea. P577

Ice Draughtsman Wanted, thoroughly experienced in Refrigerating Work (ammonia compression). Wages £5 per week.—Address, stating age, experience, and references, to 3182, Engineer Office, 33, Norfolk-street, Strand, W.C. 3182

Mechanical Draughtsman, to take second position in drawing-office, REQUIRED by BOWES SCOTT and WESTERN, Ltd., Broadway-chambers, Westminster, S.W. State full particulars by letter. P.99

Wanted, Foreman, for a Firm of Brewers' Engineers. Must have filled a similar position before, and be well up in brewery and distillery work. State age and wages required.—Address, 3162, Engineer Office, 33, Norfolk-street, Strand, W.C. 3162

Brass Moulder.—Wanted, Working ING FOREMAN, to take charge of Brass Foundry; must be experienced in casting heavy hydraulic gun-metal work.—Apply, by letter, stating age, experience, and wages required, to the HYDRAULIC ENGINEERING COMPANY, Limited, Chester. 3148

Foreman Wanted over Fitters and Machine Men, about 30 hands. Permanent situation to suitable man. Preference given to one used to printing or similar machines and card system of timekeeping. State age, wage, experience, with recent testimonials.—LEWIS and POINTONS PANIFICATION, Limited, Wellington, Salop. P193

The Proprietors of "The Ironmonger" are about to APPOINT a GENTLEMAN to TAKE CONTROL of the Advertisement Department of Birmingham and its district, and to supervise their Birmingham Office; salary and commission.—Apply, in writing, to MORGAN BROTHERS, 42, Cannon-street, London, E.C. P626

Wanted, an Experienced ENGINEER, to call upon Architects, Manufacturers, Hospitals, Workhouses, &c., where steam plants are used, and place before them a new System of Effecting Economies in Steam and Coal Consumption. The gentleman appointed will require to be thoroughly well up in the technicalities of steam engineering, and must be able to describe the system to intending clients in an intelligible manner. The system is new, very effective, and only requires the right man to place it commercially on the market. Applicants to state age, experience, when at liberty, salary required, and other particulars. All applications will be treated in the strictest confidence, and unless the fullest particulars are given of experience, firms with whom applicants are or have been employed, their applications will not be considered.—Address, 3209, Engineer Office, 33, Norfolk-street, Strand, W.C. 3209

Works Manager's Clerk Wanted at once. Must have had experience in the routine of a works manager's office.—Apply, stating the fullest particulars as to experience, age, and wages expected, to WILLANS and ROBINSON, Limited, Ferry Works, Queen's Ferry S.O., Flintshire. 3183

Chief Clerk Wanted in an Engineer's Office; must have had a good general experience, and be capable of controlling a staff of clerks; one who is able to re-organise and supervise cost system on up-to-date lines preferred. Good opportunity for a suitable man; age not under 30.—State experience and salary required, to 3174, Engineer Office, 33, Norfolk-street, Strand, W.C. 3174

Wanted, a Young Man, with previous experience of spring compound traction engines (Fowler's preferred), to go out with and DRIVE a TRACTION PLANT, owned by Englishman, in the Argentine Republic; engagement for year with view to permanency; good salary; board and lodging found.—Write, giving references, and stating age, qualification, previous experience, salary, &c., to H. W. THOMSON, Budleigh Salterton, Devon. 2153

Wanted Immediately, a First-class PATTERNMAKER for General Engineer's Works near Blackfriars. Wages 42s. per week of fifty-four hours, and a permanent job offered to a really good man and one used to all classes of work.—Address, P627, Engineer Office, 33, Norfolk-street, Strand, W.C. P627

Patternmaker Wanted as Working PARTNER in a well-established and profitable patternmaking business, with or without capital. State experience.—Address, P608, Engineer Office, 33, Norfolk-street, Strand, W.C. P608

Platers Wanted Immediately, experienced in Steel Roofs. Good wages paid.—Apply, stating age and references, to REES and KIRBY, Ltd., Swansea. P491

Smith, Foreman, Required for country shop. Must be energetic and used to builders' work, &c., and a good manager of men.—State age, particulars of past employment, references, and wages to M. W., 133, Victoria-road, Aldershot. P588

Wanted, Appointment as ASSISTANT (Engineer or Manager); good experience engineering and building; neat draughtsman; accustomed to men.—P625, Engineer Office, 33, Norfolk-street, Strand, W.C. P625

Wanted, Re-engagement as CHIEF ENGINEER or MECHANICAL SUPERINTENDENT in large Factory or on Estate. Experienced in the management of steam and water power, grinding, pumping, hydraulic pressure, and woodworking machinery, and general engineering and millwright work. Fair draughtsman, and used to the control of workmen. Good testimonials and reference. No objection to going abroad.—Address, P619, Engineer Office, 33, Norfolk-street, Strand, W.C. P619

Advertiser Seeks Engagement as ASSISTANT ENGINEER or JUNIOR DRAUGHTSMAN; 6 years' experience, 3 years college and 3 years works; with excellent references.—F. COCKLE, Union-street, Plymouth. P614

Assistant Manager, or Shop FOREMAN; expert tool and jig designer; rapid repetition; interchangeable and modern tool room systems; automatic and American tools and methods; good organiser.—Address, P605, Engineer Office, 33, Norfolk-street, Strand, W.C. P605

Civil Engineer M.I.C.E., Wh. Sc., with best experience of modern dock and railway construction and maintenance, REQUIRES ENGAGEMENT. Highest references.—Address, P480, Engineer Office, 33, Norfolk-street, Strand, W.C. P480

Engineer Desires Country Appointment. Works Manager or otherwise. Good systematiser, and used to supervision of men. Salary not an object. — PRACTICAL, 34, Narborough-street, Fulham, London, S.W. 3193

Engineer, Up-to-date, Practical man, used to control of men, and the latest and quickest methods of machine work, SEEKS ENGAGEMENT, CONTRACT, or in CHARGE.—Address, 337, Summer-lane, Birmingham. P616

Engineer, 20 Years' Experience (5 years chief draughtsman), locomotive, general, hydraulic, electrical, millwork, &c., DESIRES APPOINTMENT as MANAGER of small works or any Position of Trust where above experience could be utilised; energetic and good correspondent; full particulars and first-class references (including testimonial from present employers) on application.—Address, P598, Engineer Office, 33, Norfolk-street, Strand, W.C. P598

Engineer (32), First-class B.O.T. Certificate, DESIRES CHARGE of PLANT or other POSITION of TRUST; refrigerating and electric lighting experience; excellent references.—Address, P632, Engineer Office, 33, Norfolk-street, Strand, W.C. P632

Gentleman (25), Seven Years' shop experience, DESIRES POST. Will accept any position in or near London.—Address, P581, Engineer Office, 33, Norfolk-street, Strand, W.C. P581

Marine and Mechanical Engineer (27), German, DESIRES ENGAGEMENT as Assistant or Draughtsman. Six years' shop experience and 3½ years technical schools training.—P. HUFFNER, 84, Breakspears-road, S.E. P580

Mining Mechanical Engineer DESIRES APPOINTMENT. Experienced in planning and setting out surface works, designing of reduction works, electric installations; would act as assistant to a consulting engineer, or erect plants going abroad.—Address, P623, Engineer Office, 33, Norfolk-street, Strand, W.C. P623

A Young Man (22) Wants SITUATION in drawing-office as JUNIOR DRAUGHTSMAN or IMPROVER; small salary, 6½ years in shops and office.—Address, P612, Engineer Office, 33, Norfolk-street, Strand, W.C. P612

Draughtsman, with Experience in designs, calculations, and detail drawings for bridges, roofs, railways, and waterworks, DESIRES SITUATION.—Address, P633, Engineer Office, 33, Norfolk-street, Strand, W.C. P633

Draughtsman, 8 Years' Experience, WANTS POST with Steelwork Contractors; experienced in design of roofs, bridges, and structures, working drawings, ordering material, and general contractors' work.—Address, P613, Engineer Office, 33, Norfolk-street, Strand, W.C. P613

Electric Power Stations. — DRAUGHTSMAN and ENGINEER, experienced in preparing plans for the above (both buildings and the lay-out of entire plant complete), also general central station work, DESIRES RE ENGAGEMENT; could undertake supervision if required.—Address, 3235, Engineer Office, 33, Norfolk-street, Strand, W.C. 3235

Expert Tracer or Assistant DRAUGHTSMAN DESIRES a SITUATION at the coast or country; 11 years' experience; married; about 35s. per week.—Address, P578, Engineer Office, 33, Norfolk-street, Strand, W.C. P578

Steel, Iron and Building Construction. — An experienced DRAUGHTSMAN DESIRES to FILL UP part of his time in London; stresses and inspections; highest references.—Address, P596, Engineer Office, 33, Norfolk-street, Strand, W.C. P596

Bridge, Roof, and Girder Work FOREMAN DISENGAGED; good organiser, accustomed to control over 350 men; latest methods of production; age 32.—Address, P582, Engineer Office, 33, Norfolk-street, Strand, W.C. P582

Foreman Rivetter. — Situation WANTED. Thorough knowledge of Hydraulic and Pneumatic Work. Well accustomed to men on either piecework or time. Highest reference.—Address, P586, Engineer Office, 33, Norfolk-street, Strand, W.C. P586

Foreman Engineer, Prepared to take charge of large Works; all-round practical man; good experience, and capable of taking charge of men; age 40.—Address, P591, Engineer Office, 33, Norfolk-street, Strand, W.C. P591

Mechanical and Constructional Engineer SEEKS SITUATION as Head Foreman Pattern and Template Maker, or Works Manager where practical and methodical man is required. Good reference.—Address, P584, Engineer Office, 33, Norfolk-street, Strand, W.C. P584

Steel Frame and Wagon Work.—FOREMAN DISENGAGED. Thoroughly accustomed to covered goods, hopper and tank wagons &c.; also carriage underframes. Age 32.—Address, P583, Engineer Office, 33, Norfolk-street, Strand, W.C. P583

Mechanical Engineer (30), experienced in engine work, pumping machinery, and general engineering, technical and commercial, OPEN to REPRESENT a good FIRM at home or abroad, or other responsible position; French and German.—Address, P597, Engineer Office, 33, Norfolk-street, Strand, W.C. P597

South Africa.—Gentleman, about to visit the mines and engineering firms, &c., WISHES to MEET with FIRMS WILLING to SHARE travelling EXPENSES. Highest references.—Address, 1817, Emrin and Co., 33, Norfolk-street, Strand, W.C. 1817

Bookkeeper, Thoroughly Competent, with 14 years' excellent references, DESIRES ENGAGEMENT.—Address, P617, Engineer Office, 33, Norfolk-street, Strand, W.C. P617

Engine Driver, lately Returned from the Gold Coast, SEEKS RE-ENGAGEMENT; used to loco's, steam motors, and stationary engines; well up in repairs; ten years' good refs.; home or abroad.—J. S., 11a, Marinefield-road, Fulham, S.W. P626

Junior Blacksmith, Age 23, SEEKS SITUATION; served time in Engineering Works; London preferred.—Address, P628, Engineer Office, 33, Norfolk-street, Strand, W.C. P628

A.—Electrical and Engineering and Motor Firms have VACANCIES in London and country works for young GENTLEMEN to train for permanent appointments as PUPILS; ages 15 to 25; premium required £50 and upwards.—For application forms with particulars, address, Box E., Taylor's, 154, Fleet-street, E.C. 1906

Engineering Pupil. — Firm (Government Contractors), employing 500 hands, have VACANCY; varied classes of work done, affording excellent opportunities; premium moderate.—Address, 1161, Engineer Office, 33, Norfolk-street, Strand, W.C. 1161

Engineering Pupils. — The Horseley Company, Limited, have VACANCIES for PUPILS.—For particulars, apply the SECRETARY, Horseley Works, Tipton. 2045

Young Gentleman Desires to be ARTICLED to Engineer or Contractor with work in hand; railway, waterworks, or dock; premium about £50 per annum.—Address, P611, Engineer Office, 33, Norfolk-street, Strand, W.C. P611

Working Partner, Engineer, WANTED in an old-established Steam Road Hauling, Rolling, and Thrashing Business; good turnover and profits; can take half share in business; capital about £500; every information afforded.—Address, 3201, Engineer Office, 33, Norfolk-street, Strand, W.C. 3201

A Firm of Engineers, having good specialities in Petrol Motors and Motor Accessories, REQUIRE CAPITAL to EXTEND their BUSINESS.—Gentlemen with money to invest are requested to address, P604, Engineer Office, 33, Norfolk-street, Strand, W.C. P604

Experienced Engineer Wishes to ACQUIRE INTEREST in Going Concern, to act as Works Manager and assist generally; energetic and practical; under 30.—Address, in strict confidence, stating what capital required, and full particulars, to P535, Engineer Office, 33, Norfolk-street, Strand, W.C. P535

Light Motor Vehicles for Trade DELIVERY.—Engineer (32) A.M.I.M.E., six years' motor practice, good connection, responsible for well-known productions, would LIKE to COMMUNICATE with FIRM, view to Manufacture and Engagement. Fullest enquiries.—Address, P566, Engineer Office, 33, Norfolk-street, Strand, W.C. P566

Practical Engineer and General Ironfounder WANTS PARTNER with £1000 to £1500. Old-established business, up-to-date appliances, sound connection.—Applications—principals or solicitors, no agents—to 3145, Engineer Office, 33, Norfolk-street, Strand, W.C. 3145

Practical Works Manager, Now disengaged, wide experience, can INTRODUCE Unlimited Quantity of Profitable WORK of which he is a specialist, to firm with good plant, and take financial interest in same if desired.—Address, 79, Effingham-road, Lee, S.E. P610

£1000 Wanted to Complete a CONTRACT for erection of machinery. Would participate in very large profits.—Address, P. D., care of Housekeeper, 63, Queen Victoria-street, London. P600

Consulting Engineer.
W. T. OLIVE, M. Inst. C.E.,
P.O. BOX 1103,
P521 CAPE TOWN.

Wanted, a Quantity of Second-hand or PORTABLE RAILWAY, about 14 lb. per yard, 24in. gauge, and wagons to suit. State lowest price f.o.r.—Address, 3197, Engineer Office, 33, Norfolk-street, Strand, W.C. 3197

Wanted at Once, a New or Good Second-hand Powerful High-speed PUNCHING MACHINE, to punch 1in. holes through 1in. plate; the width between punch and die holders about 12in.; depth of gap 2ft. 6in.; to be fitted with stop motion, and to be either belt or steam driven; also for a Plate Edge PLANING MACHINE to plane 30ft. long.—Address, with full particulars, price, &c., to C. and A. MUSKER, Limited, Liverpool. 3171

Wanted, for an Ironfoundry, a HAND OVERHEAD TRAVELLER, to carry about 15 tons, with a span of 19ft 6in.—Address, stating full description, with tracing, lowest possible price, and where seen, P622, Engineer Office, 33, Norfolk-street, Strand, W.C. P622

Wanted, New or Good Second-hand Horizontal LAUNCH BOILER, with about 100 sq. ft. of heating surface and not less than 120 lb. working pressure.—COLLIS, Limited, Launch Builders, Southampton. P620

Wanted, Second-hand Pair LAUNCH ENGINES, cyls. about 7in. × 11in., simple or compound surface-condensing, with propeller, stern tube, and shaft. Also new MARINE BOILER, 7ft. long × 5ft. 6in. dia.—Reply, with full particulars, to C. F., care of J. W. Vickers, 5, Nicholas-lane, E.C. 3161

Firms having Direct-coupled TRACTION UNITS (500 K.W. or over) ready for immediate DISPOSAL are INVITED to COMMUNICATE with P606, Engineer Office, 33, Norfolk-street, Strand, W.C. P606

Machinery Wanted. — Pump, steam duplex, to throw about 20,000 gallons per hour, with 6in. piping and upright boiler, size about 10 × 5, complete; must all be in first-class condition. State lowest price and where can be seen.—MANAGER, Cove Quarries, Ecclefechan. 3186

Piping.—Wanted, Cheap, 600ft. Iron and 1800ft. Earthenware 12in. PIPING; pipes slightly damaged would answer the purpose.—MANAGER, Basted Mills, Wrotham, Kent. P587

A Corliss Compound Side-by-side CONDENSING ENGINE, 300 I.H.P., 32in. and 50in. cylinders, 6ft. stroke, steel crank shaft; a capital engine, first-rate order, and just stopped work.
One Tandem Compound CONDENSING ENGINE, 26in. and 54in. by 5ft stroke, by Yates and Thom.
One Tandem Compound CONDENSING ENGINE, 30in. and 54in. trunk frame bed plate, 16ft. belt fly-wheel.
One Cross Compound ENGINE, practically new, about 200 I.H.P., by Robeys, 14in. and 23in. by 33in. stroke.
One Ditto Ditto, by Daniel Adamson, 12in. and 20in. cylinders, 24in. stroke.
Tandem CORLISS ENGINE, 14in. and 24in. by 30in. stroke, thoroughly overhauled, rope wheel.
One Ditto Ditto, 13in. and 23in. by 3ft. stroke, rope wheel.
One Side-by-side Close-coupled COMPOUND ENGINE, 50 I.H.P., by Marshalls.
Dozens of SINGLE ENGINES, all sizes.
(1) All are in stock here. (2) All second-hand. (3) Prices are right.
THOMAS MITCHELL and SONS, Ltd., Bolton.
Established 65 years ago. 3045

Aerial Ropeway (Endless Rope system), length 20000ft. to 30000ft., capacity about 12 tons per hour, load 5 cwt. Particulars on application.
ARC LAMPS, ten Crompton-Pochin, open type, 26in. enamelled reflectors without globes; not quite new.
CABLEWAY, Henderson Cableway for 3-ton load, span 400ft. to 600ft.; others in progress. Particulars on application.
CABLEWAY.—Henderson CABLEWAY for 6·7 ton load, span 800ft. to 1000ft.; improved friction gear; loco-type boiler; latest improvements. Towers can be arranged to suit site. Full particulars on application.
CRANES, Scotch Hand Derrick, 10, 15, 20, 30 cwts., 2, 3, 4, and 5 tons, new; ready and in progress.
CRANES, Scotch Steam Derrick, 3, 5, 7, and 10 tons, new; ready and in progress. New designs. High-class materials and workmanship. Low prices.
GRINDSTONE DRESSERS, improved, for truing up grindstones. Same as used in our own shops.
LIFT, hand-power passenger lift, suitable for hotel, mansion, dwelling-house, &c.
ROCK DRILLS, 2¼in., 2¾in., 3in., 3½in., 3¾in. cylinders, universal splitting stands, splitting carriages, tripods, bars, &c.
STEAM LAUNCH, length over all 37ft., beam 6ft. 4in., speed 10 miles. Full particulars on application.
WIRE ROPES, all sizes and descriptions for cranes, hoists, mooring purposes, haulages, stays.
SURPLUS STOCK TO BE DISPOSED OF.
Full particulars and prices on application to—
JOHN M. HENDERSON AND CO.,
ENGINEERS, ABERDEEN.
Telegraph, "Cranes, Aberdeen." See displayed advertisement last week and next, page xv. 1340a

Air Compressors for Raising Water; Complete Plants contracted for and fixed.—F. W. BRACKETT and CO., Hythe Bridge Ironworks, Colchester. A1907

Blakes Marsden 30 by 13 CRUSHER, ELEVATORS, ENGINES, Contractor's END-TIP WAGONS, 4ft. 8in. gauge, &c. &c.—GEO. V. FERRY, Neath, South Wales. 3149

Brickmaking Plant, Complete, never been used, by Fawcett (Ltd.), Leeds, designed to make 10,000 bricks per day, for SALE, owing to death of purchaser; will be sold cheap.—Full specification on application to MICHAEL WATSON, Mechanical Valuer, St. Nicholas-buildings, Newcastle-on-Tyne. 3158

Electric Generating Plant for SALE; in first-rate condition; capacity of plant, 35 K.W. and 90 K.W., 105 volts; direct-coupled to Bellis engines. Also BOILERS, SWITCHBOARD, &c.; low price for cash.—Apply, PLANT, care of Walker's Advertising Agency, 79, Cornhill, E.C. P542

Electric Light Engines for Sale.—Side-by-side Horizontal Compound Engine (by Fowler and Co.), 20in. and 35in. cyls., 36in. stroke; 15ft. rope fly-wheel; new in 1896. Horizontal Compound Corliss ENGINE (by Victor Coates and Co., Belfast), 17in. and 34in. cyls., 36in. stroke; 14ft. rope fly-wheel; new in 1892. Side-by-side Horl. Comp. ENGINE (by Fowler and Co), 11in. and 18in. cyls.; 20in. stroke; 10ft. rope fly-wheel; new in 1893. Three Vertical Side-by-side Compound ENGINES (by Brush Electrical Company), 9in and 15in. cyls., 10in. stroke; rope fly-wheels 6ft. 4in. diam. The above engines may be seen running. — For further particulars apply THOS. W. WARD, Albion Works, Sheffield. Telegrams:—"Forward, Sheffield." 3134

End of Contract:—
LOCO. STEAM CRANE, 40t. 84in. gauge, all motions by steam, self-propelling, boiler insured for 80 lb., Priestman's 1-ton grab, equal new.)
7ft. 6in. MORTAR MILL, under-driven, heavy rollers.
LOCO. ENGINE and BOILER, been driving same
All at liberty June 30th. Low price accepted for prompt buyer
Apply for price, &c., BRITTAIN and CO., Stoke-on-Trent. 3180

For Hire, Pumps and Well-boring TOOLS for Contractors, Deep Wells, &c., 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 978 Hop. 822

For Immediate Sale, Powerful HORIZONTAL BORING MACHINE, by Hulse, bore up to 24in. dia., self-acting sliding head; weight about 6 tons; now fixed; price £75 to clear, a bargain.—WILLIAMS and SON, South Bermondsey Station, London. 3202

For Immediate Sale. — Three ACCUMULATORS, 5in. ram, with 3 SETS of PUMPS. Buyer may have one accumulator, two or three separately or together.
Address, CHARLES D. PHILLIPS, Emlyn Works, Newport, Mon., and Gloucester. 3150

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Fawcett, Preston and Co., Ld
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Jenkins, W. J., and Co., Ld
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Reavell and Co., Ld
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